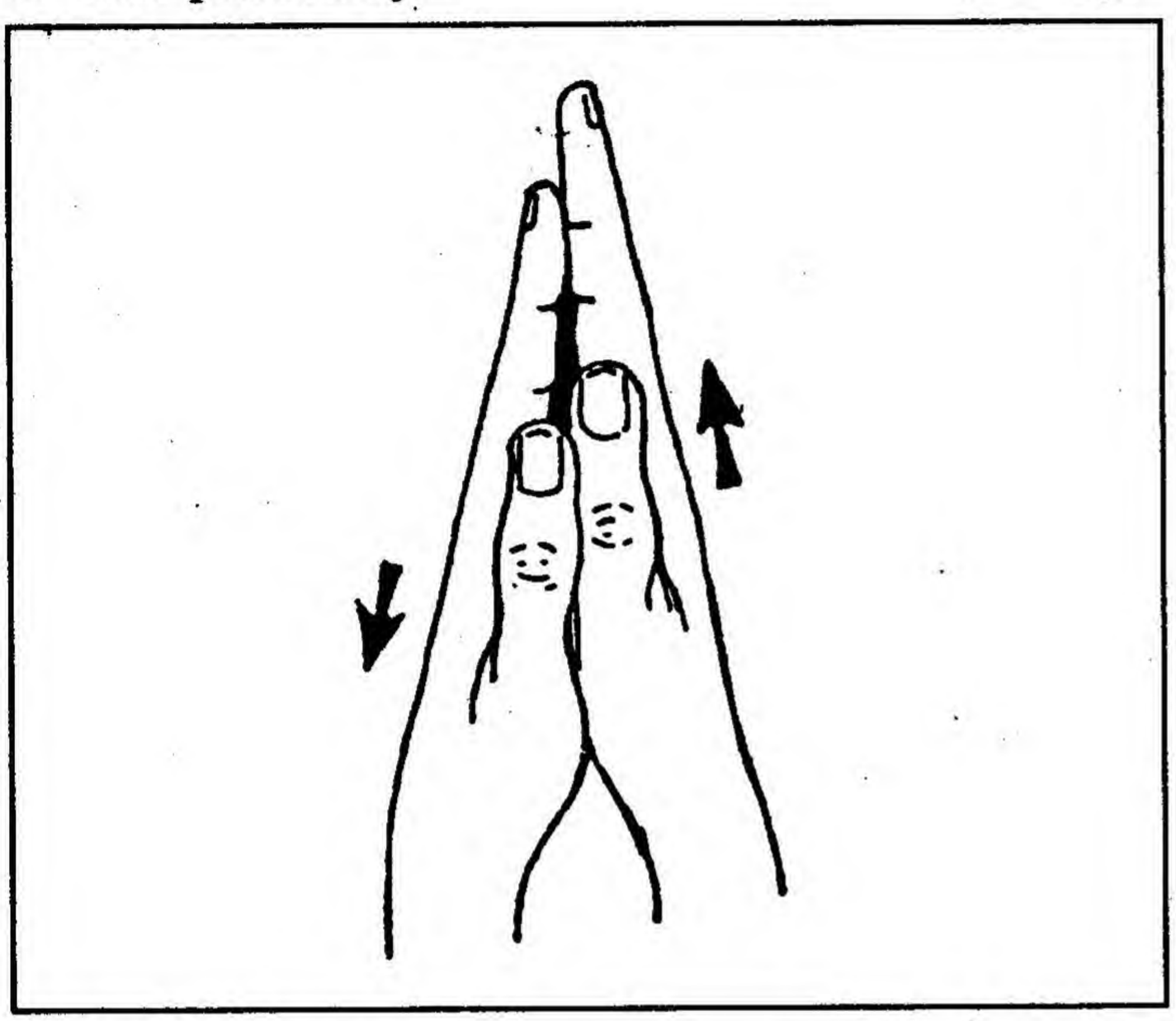
46 Rubbing the hands

Energy
Transformation of energy

Materials

1. Your palms only.



What to do ?

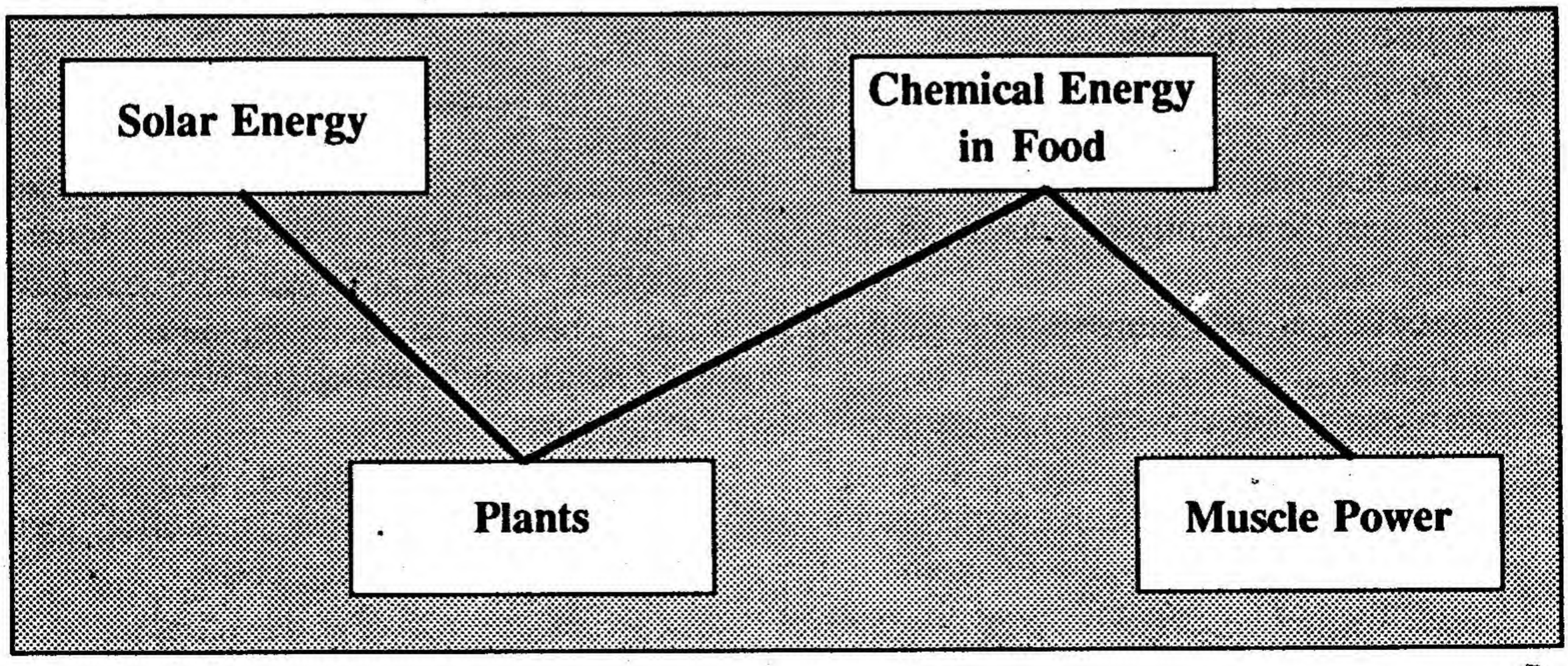
1. Rub your palms a number of times. You will observe that the palms have warmed up.

Students to enquire

1. Why do the palms get warm when rubbed together ?
2. What is the primary source of heat energy ?

Explanation

1. When the palms are rubbed there is friction between the palms, and the molecules in the palms start vibrating faster. Owing to this heat is generated and the temperature increases.
2. Muscle energy makes the palm move. Muscle energy is obtained through the intake of food. Plants prepare food through photosynthesis. Hence, solar energy is the primary source of heat energy.



Heat
Conduction

Which heats up first-1

47

Materials

1. Two corks
2. 10cm. aluminium wire-1
3. 4cm. aluminium wire-2
4. Candle and matches

What to do ?

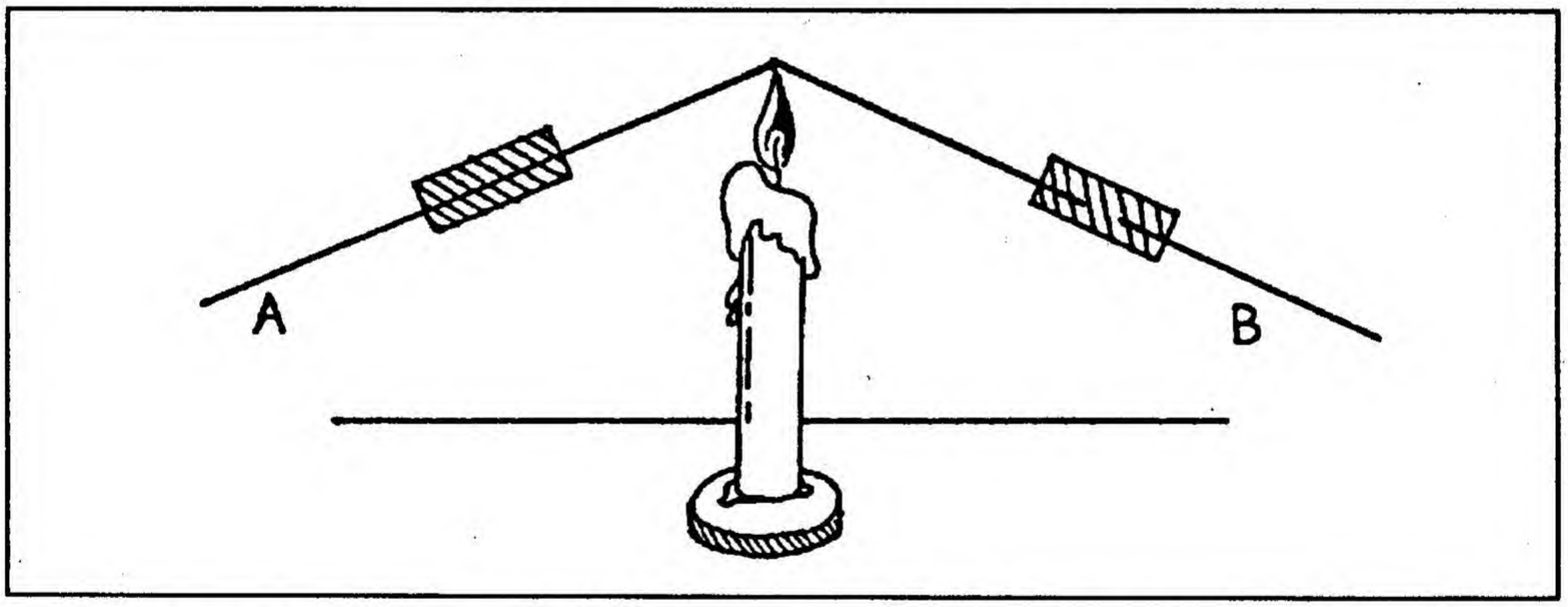
1. Insert the aluminium wires into the corks as shown in the figure.
2. Hold the two ends of the aluminium wires with the two hands. Bring the other two ends together.
3. Ask your friend to hold a lighted candle at the junction of the two wires so that both the wires are equally heated.
4. You will observe that it will be difficult for you to hold the single wire A for a long time. The wire A is heated much faster than the wire B with two smaller wires.

Students to enquire

1. Why can not you hold the wire A for a long time ?
2. Why can you hold the wire B for a long time ?
3. How was heat conducted along the wire A ?
4. If you had held the wire A wrapped with paper or cloth, how would you have felt the heat ?

Explanation

1. Aluminium is a good conductor of heat. Hence, it is heated quickly. Hence, you can not hold the wire A for long.
2. Wire B has two parts connected through a cork. Cork is a very bad conductor of heat. Hence, the heat of the part heated by the candle can not reach quickly to the other part of the wire B held with the hand .
3. The process of heat flow along the wire A is called conduction.
4. Paper and cloth are bad conductors. Hence, if you hold a wire wrapped with paper or cloth, it will take much longer time for the heat to reach your hand.



48 Which heats up first-2

Heat
Conduction

Materials

1. 15-20cm. long thin (2-3mm dia) wires of copper, aluminium and iron having the same length and diameter.
2. Candle and matches.

What to do ?

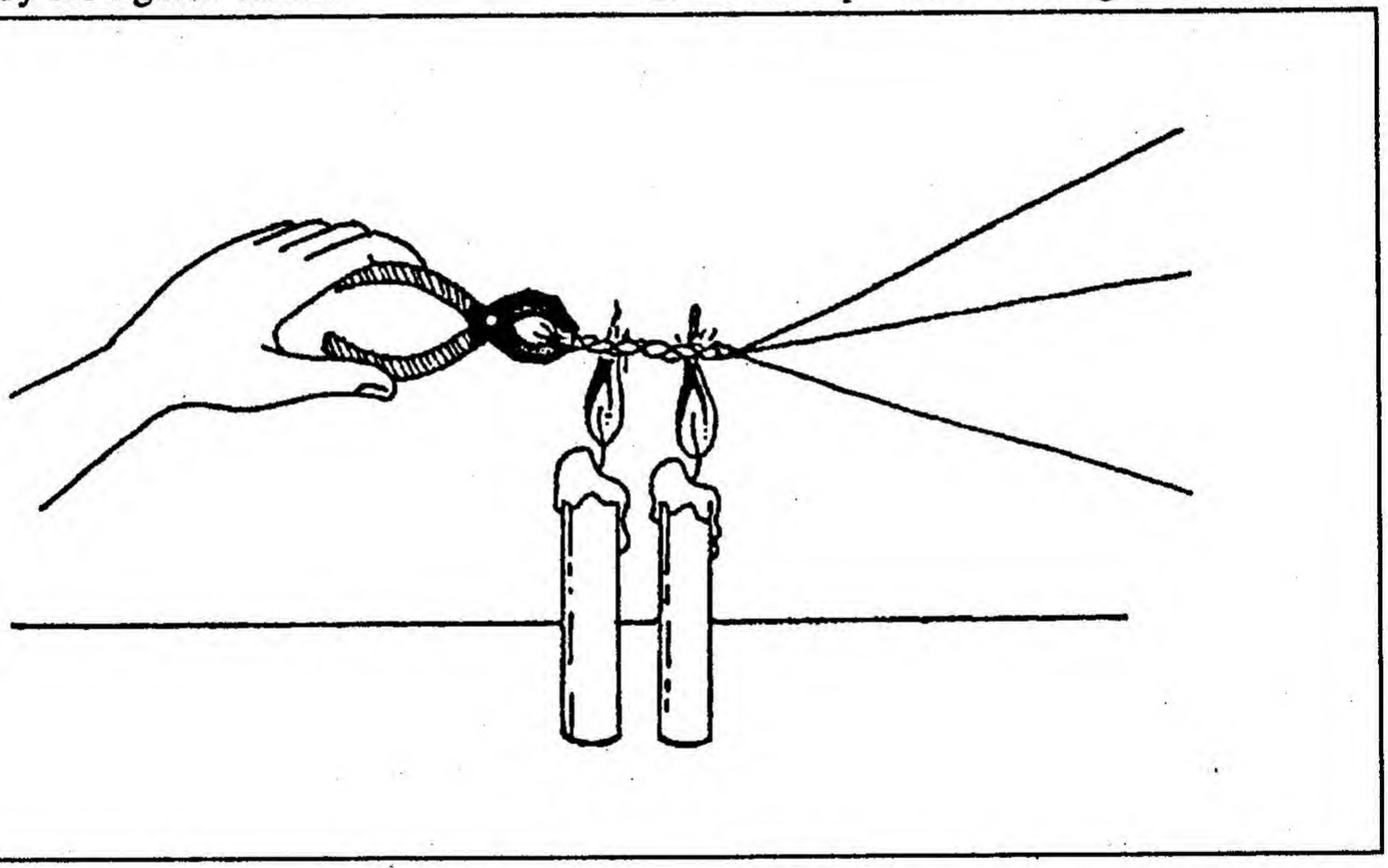
1. Tie one end of each wire together.
2. Ask your friend to heat the junction of the wires by the lighted candle.
3. After half a minute or so touch the ends of the wires and try to observe which one is heated most. You will observe that the copper wire will be heated the most and the iron wire, the least.

Students to enquire

1. Which metal conducts heat the fastest ?
2. Which of the parameters you have to keep constant ?
3. For which difference in the property of the materials could you perform the experiment ?

Explanation

1. Copper conducts heat the most and iron, the least.
2. In this experiment the length and diameters of the wires and the heat applied to the three wires were kept constant.
3. The conductivity of different materials is different. The conductivity of a substance depends upon its molecular structure. The difference in the property of substances was utilised to conduct the experiment.



Heat
Conduction

The cloth that does not burn

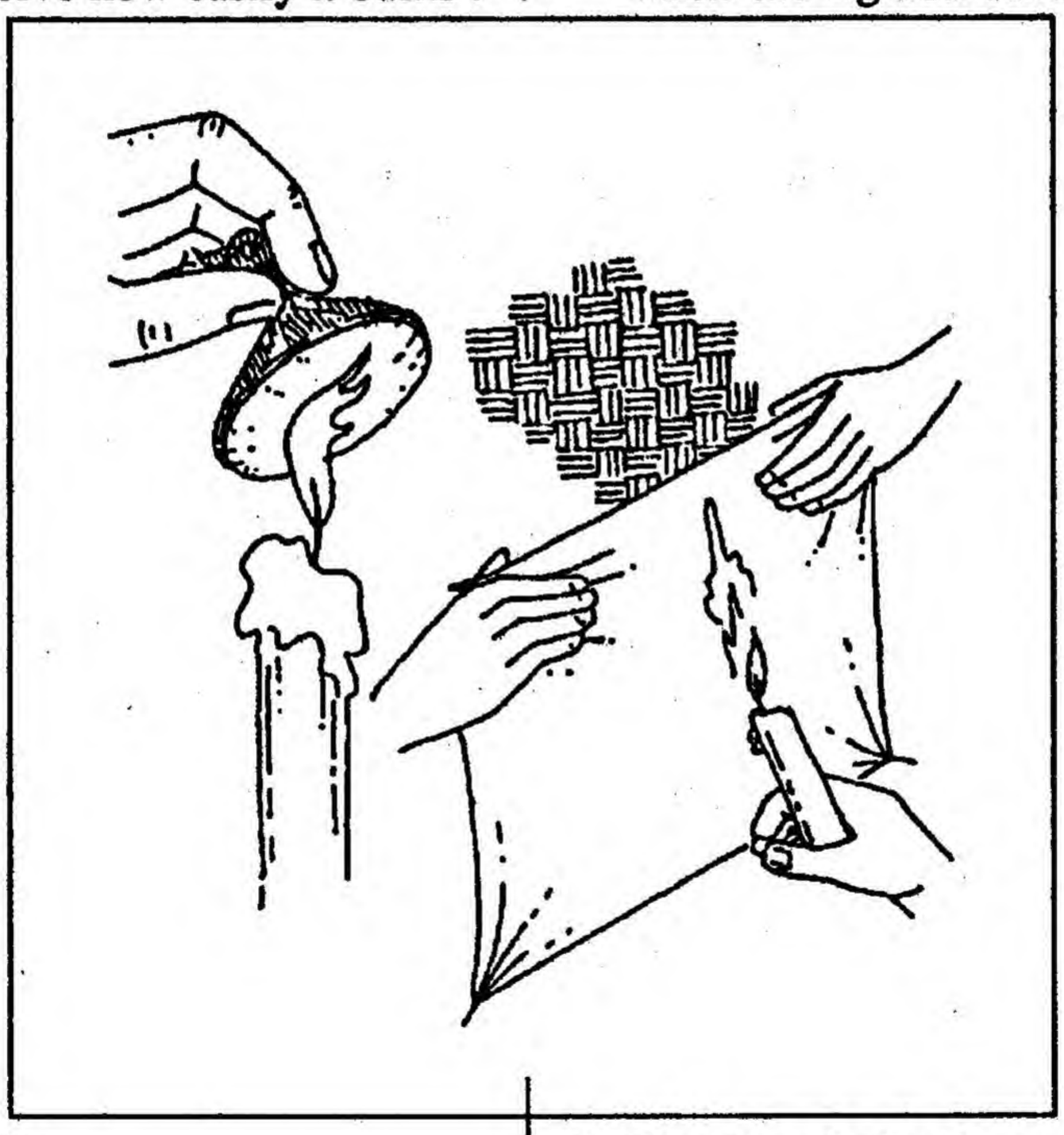
49

Materials

1. A 50 paise or 1 rupee coin
2. A piece of old cloth
3. Candle and matches .

What to do ?

1. Keep the cloth stretched and hold the candle on the cloth. Observe how easily it burns .
2. Now, wrap the cloth tightly over the coin and hold it with your left hand. Hold the lighted candle on the cloth for a few seconds. The cloth is not burnt.
3. Remove the cloth and touch the coin. You will feel it hot.



Students to enquire

1. Why is it easier to burn the cloth without the coin ? .
2. Why does not the cloth burn when the coin is there ?
3. Why does the coin heat up ?
4. If instead of a coin a piece of wood or plastic was taken, what would have happened to the cloth ?
5. If the candle is held on the cloth wrapped on the coin for a long time, will the cloth burn ?

Explanation

1. The flame of the candle could raise the temperature of the cloth above its ignition point. Hence, the cloth burnt.
2. A metal is a good conductor of heat. Hence, when the lighted candle was held on the cloth wrapped on a coin, the heat from the flame would conduct quickly to the coin. Owing to this the temperature of the cloth could not rise above the ignition point. Hence the cloth did not burn.
3. As a metal is a good conductor of heat, the coin got heated.
4. Wood and plastic are bad conductors of heat. Hence,the temperature of cloth will rise above ignition point and the cloth will burn.
5. If the candle is held on the cloth wrapped on the wire for a long time, the temperature of the cloth will rise above the ignition point and the cloth will burn.

50

Which is hotter

Heat
Conduction

Materials

1. A 4"x4" piece of cloth
2. A metal plate

What to do ?

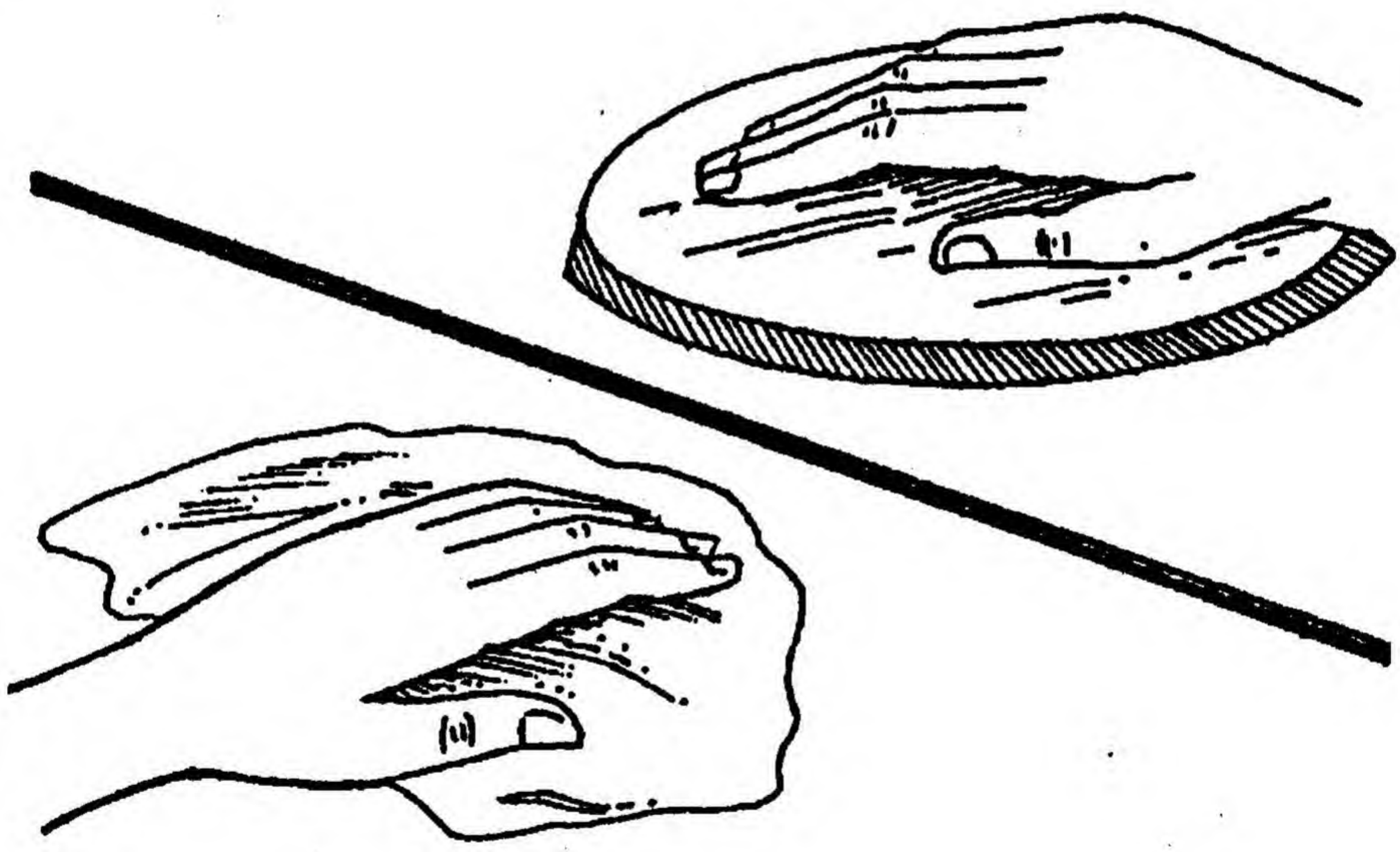
1. Place one of your hands on the cloth and the other on the plate. You will observe that though both the materials are at the same room temperature, the metal plate feels cooler.

Students to enquire

1. Why do you feel the plate cooler than the cloth?

Explanation

1. A metal is a better conductor of heat than cloth. Normally, body temperature is more than the outside temperature. When you touch both the objects with two hands the metal takes away heat from your body quicker than the cloth. Because of this your hand feels the metal cooler than the cloth.



Heat
Convection

Hot and cold water

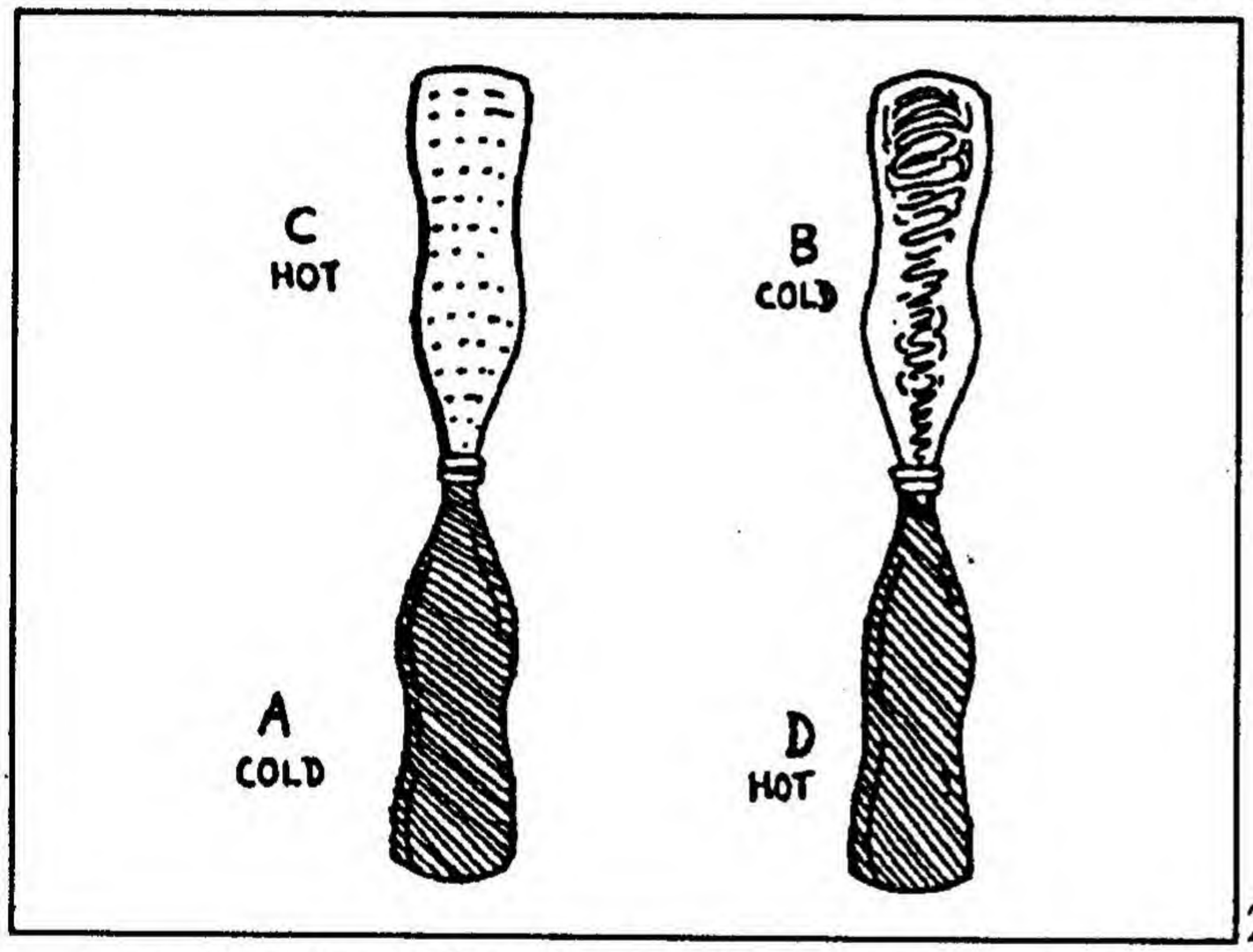
51

Materials

1. Four empty cold drink bottles
2. Colouring material

What to do ?

1. Fill the bottles A and B with cold water and the bottles C & D with hot water.
2. Mix colouring material with the water of A and D.
3. Close the mouths of the bottles B and C with your thumbs. Bring the bottles over the mouths of the bottles D and A respectively and take off your thumbs from the mouths of the bottles.
4. After some time you will observe that the water in bottle B is getting coloured. But there is no change in the colour of the water in bottle C.



Students to enquire

1. Why did the water in bottle B get coloured but why did not the water in the bottle C do so ?
2. When will the water in bottle C get coloured ?
3. If the water in all the bottles had been in the same temperature, then what changes would have happened to their colours ?
4. Why did all the bottles come to the same temperature after some time ?

Explanation

1. Density of hot water is less than cold water. So the cold water of bottle B comes down to bottle D and the hot water of bottle D moves up to bottle B by the process of convection. Thus the colourless water in bottle B gets coloured and the colour of water in bottle D becomes lighter. But the water in bottle C is hot and that in bottle A is cold. Hence the cold water in bottle A, being more dense, remains in the bottom and the warm water of bottle C tries to remain at the top. So the water in the bottles did not mix.
2. When the temperatures of bottles A and C become equal owing to radiation, exchange of water takes place between the bottles through the process of diffusion and the water in bottle C gets coloured.
3. When temperatures of all the bottles become the same, water of all the bottles become coloured through the process of diffusion.
4. All the bottles will come to the same temperature by the process of radiation.

52

Boiling iced water

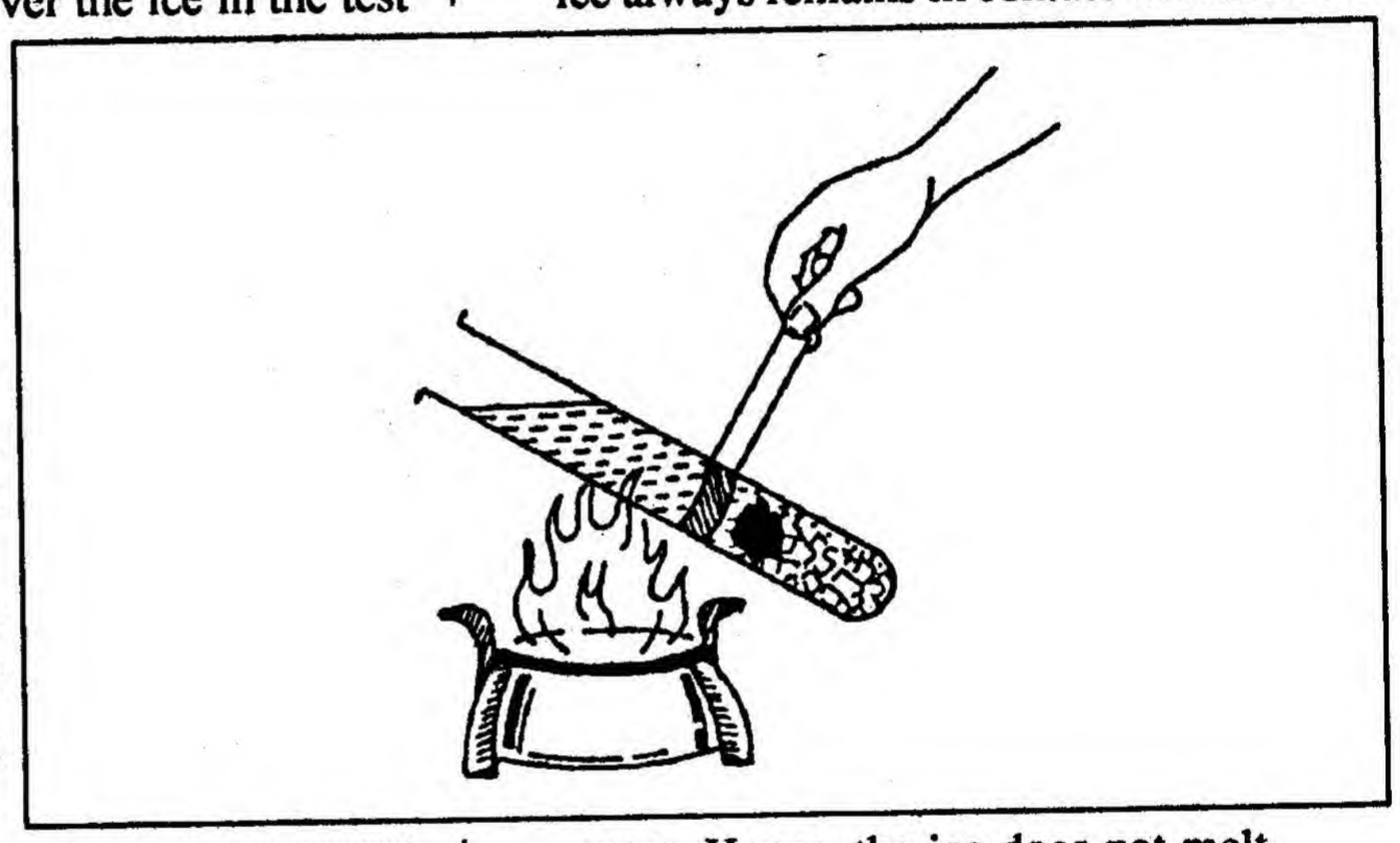
Heat
Convection

Materials

1. Crushed ice
2. A large test tube and a test tube holder
3. A small stone which can enter the test tube
4. A heater or a spirit lamp

What to do ?

1. Fill one-third of the test tube with crushed ice. Keep the stone over the ice in the test tube to hold the ice.
2. Take a little water in the test tube.
3. Hold the test tube with the holder and heat the upper portion of the test tube until the water starts boiling.
4. You will observe that water boils at 100° C but the ice does not melt.



Students to enquire

1. What is the purpose of keeping the stone ?
2. Why does not the ice melt when the water boils ?
3. If the stone were not there, could the experiment be conducted ?
4. Was the water conducting the heat well ?
5. Did the convection process work in water ?

Explanation

1. Ice could not float up because of the stone over it.
2. The water along with the ice at the bottom of the test tube is cold. Hence, its density is more than the cold water. Hence, when the upper portion of the test tube is heated, the heated water moves up. But the cold water tries to remain at the bottom. The convection process does not work. So the ice always remains in contact with the cold water. Hence, the ice does not melt.
3. The experiment could not be performed if the stone were not there. Without the stone the ice would float up and it would melt owing to the convection process.
4. Water is a bad conductor of heat. Hence, when the upper portion of the test tube was heated, the water did not conduct the heat to the ice well.
4. The convection process was not working as the cold water, being dense was always trying to stay at the bottom.

Heat
Radiation

Black is heated more

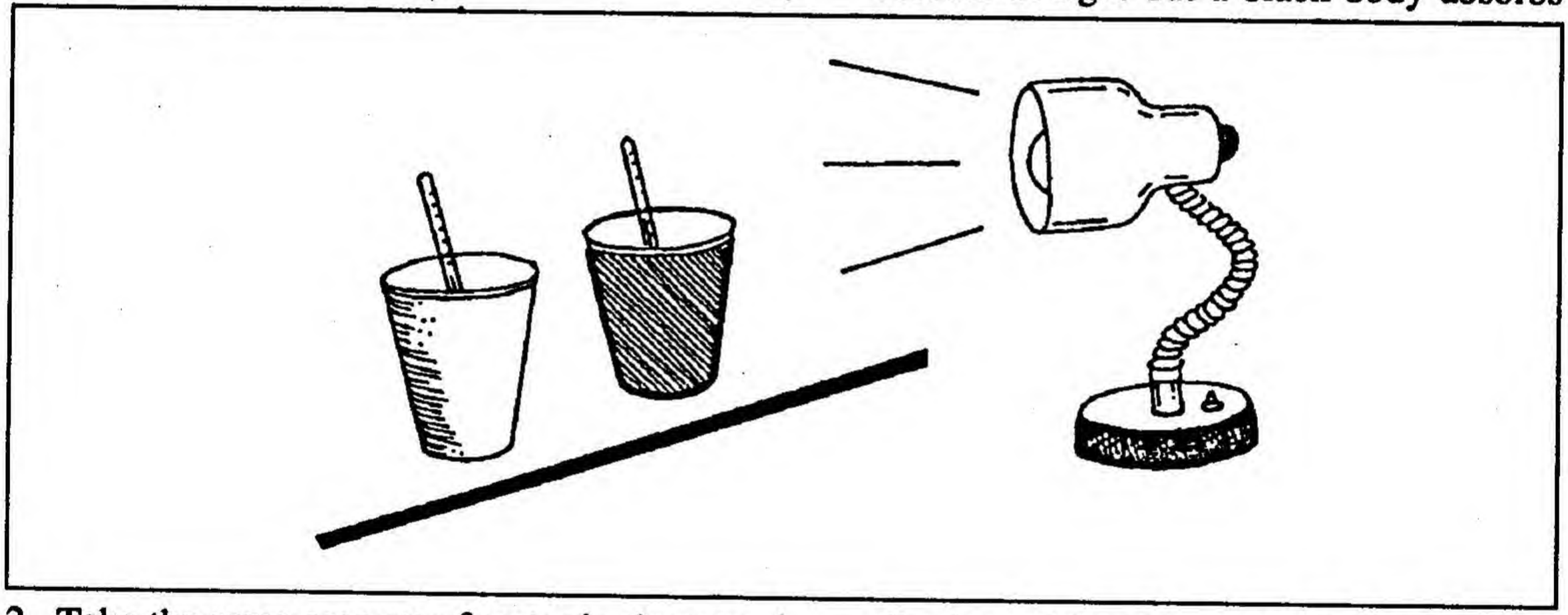
53

Materials

1. Two glass tumblers
2. Two similar thermometers
3. A piece of white paper and a piece of used carbon paper
4. A spot light

What to do ?

1. Cover one glass with the piece of white paper and the other glass with the piece of carbon paper.



2. Take the same amount of water in the two glasses and introduce the two thermometers into the glasses.
3. Turn the spotlight on and keep the glasses equidistant from the light so that both may receive the same amount of light from the lamp.
4. After 5-6 minutes record the temperatures measured by the two thermometers. You will observe that the thermometer in the glass that is covered with carbon paper records the higher temperature.

Students to enquire

1. Why does the glass covered with the carbon paper get heated more ?
2. Normally, which colours of light are more hot and cold ?

Explanation

1. A black body absorbs more radiant energy than a white body. A white body reflects all colours of light but a black body absorbs all colours. The glass covered with the piece of black carbon paper absorbs more radiant energy from the lamp but the other glass covered with the piece of white paper reflects away all colours. Hence, the water in the glass covered with the carbon paper gets heated more.
2. The warmer colours in descending order are : red, orange, brown and yellow. The sequence of cooler colours is : green, blue, purple and violet.

54 Temperature

Heat
Temperature

Materials

1. Two similar thermometers
2. A piece of cloth
3. A glass and some water

What to do ?

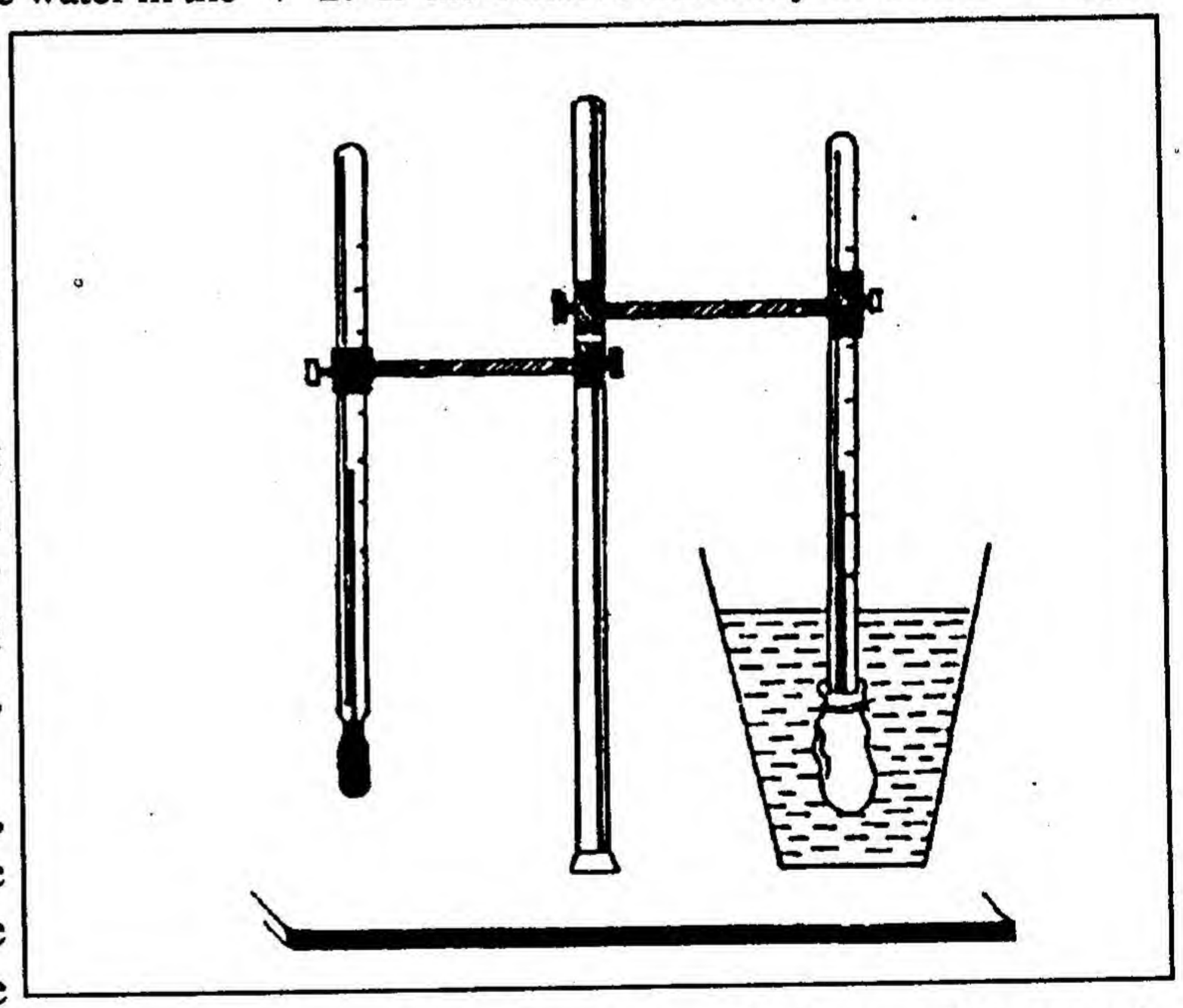
1. Record the temperatures measured by the two thermometers.
2. Cover the bulb of one of the thermometers with a piece of wet cloth. Take water in the glass and dip this thermometer in water.
   Note the temperature as measured by the thermometer.
3. Note the relative humidity from the weather reports in the newspaper.

Students to enquire

1. Is there any difference between the temperatures recorded by the dry bulb thermometer and that with the wet bulb ? If so, why ?
2. If the relative humidity is high, what difference between the temperatures measured by the two thermometers will be noticed ?
3. If the difference between the two temperatures is much, what inference can you draw about the relative humidity in the air ?

Explanation

1. When the bulb of a thermometer is wet, evaporation takes place from the wet cloth. For evaporation the water draws heat from its environment including the bulb of the thermometer. For this the thermometer gets cooled and there is a difference between the dry and wet bulb thermometers.The drier the air, the quicker is the evaporation and the lower the temperature reading in the wet bulb thermometer.
2. If the relative humidity in the air is high, then there is practically no difference in temperature between the dry & wet bulb thermometers.
3. If the difference between the dry and wet bulb temperatures is high, then it proves that the relative humidity is low.



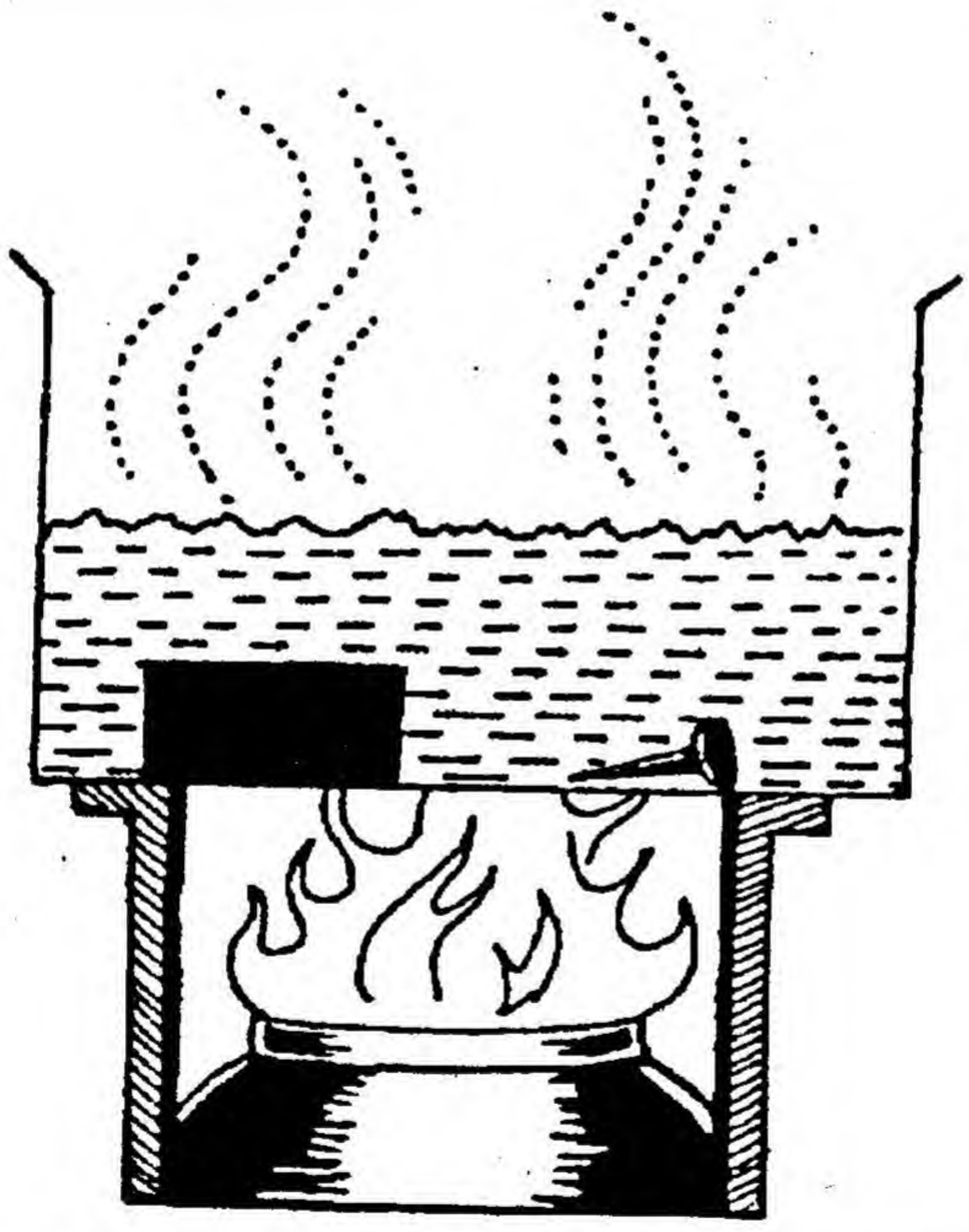
Heat
Temperature

Heat and temperature

55

Materials

1. Two glass tumblers of the same size
2. A heavy piece of iron
3. A big nail
4. Two thermometers
5. Two toys
6. Two heaters
7. A beaker.



What to do ?

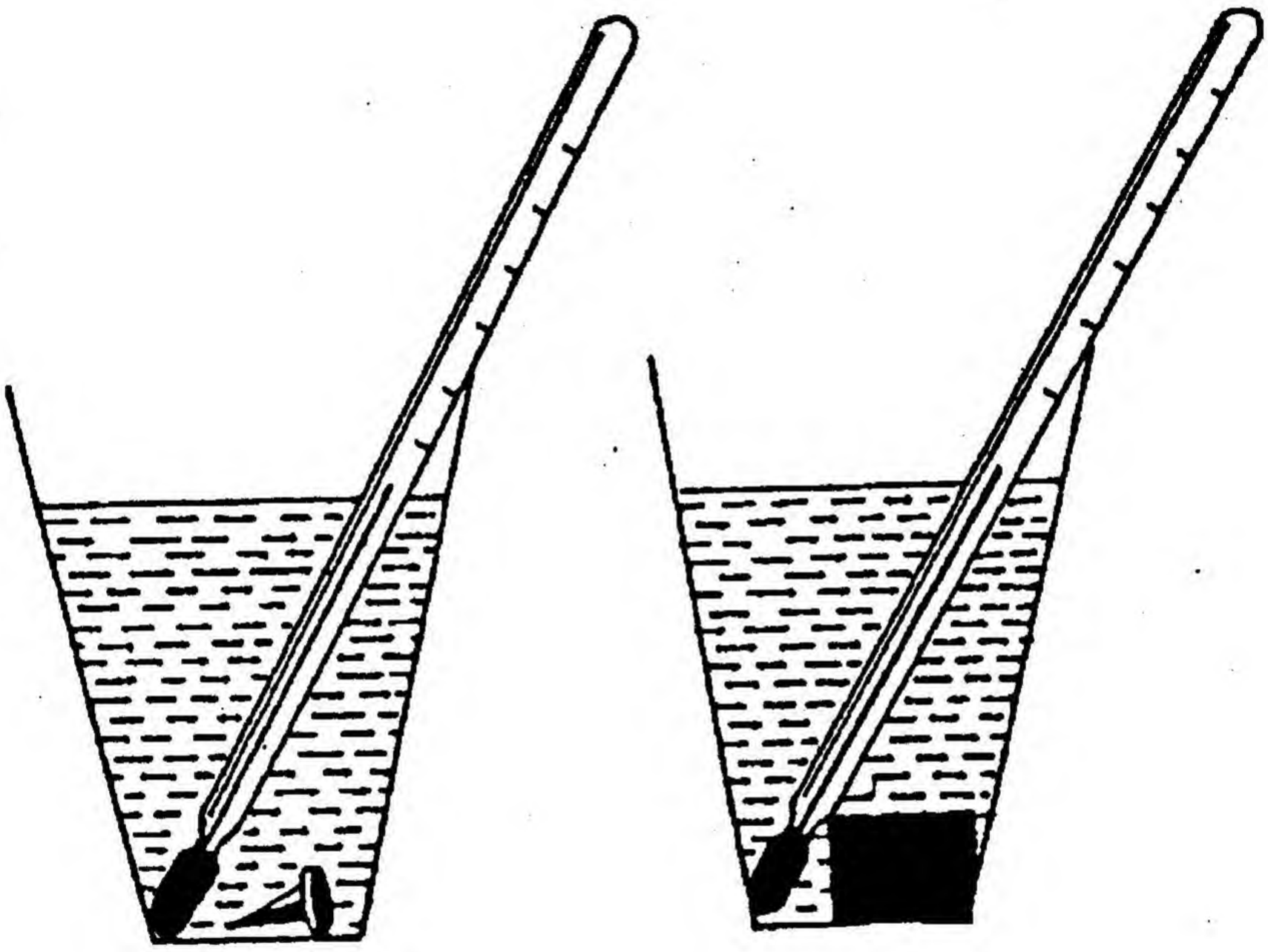
1. Put the piece of iron and the nail in the water in a beaker and boil the water.
2. Take the same amount of water (100 c.c.) in the two glasses. Measure temperatures by placing the two thermometers into the water in the glasses.
3. When the water in the beaker starts boiling replace the piece of iron and the nail from the beaker to the two glasses with the aid of the two tongs. Keep the thermometers in the water.
4. Record the temperatures every 15 seconds till the rise in temperature stops.

Students to enquire

1. What were the temperatures of water in the two glasses before the introduction of the piece of hot iron and the nail ?
2. When the water starts boiling what is its temperature ?

3. After the hot iron objects are transferred to the glasses, water in which glass becomes hotter ?
4. Why did the temperatures of water in the glasses rise ?
5. Out of the two iron picces which one has more thermal capacity ?

water in the glasses the one with the bigger object rises to a greater temperature compared to the other one.
4. The temperature of water rises because of the conduction of heat from the hot object to the water.
5. The bigger iron object has greater thermal



6. What are the factors on which thermal capacity depends ?

Explanation

1. Before the hot metal objccts were placed, the temperatures of water in both the glasses were the same, i.e., the normal room temperature .
2. The temperature of boiling water is 100°C.
3. When the hot objects are transferred to the

capacity than the smaller one because of its greater mass. So heat in the bigger object is more than the smaller one. Hence, the water in the glass in which the bigger object is placed rises to a greater temperature.
6. The thermal capacity of an object depends upon its mass and the material of which the object is made.

Heat
Temperature

Make a thermometer

56

Materials

1. A 100 ml conical flask with a rubber stopper and a tube passing through it
2. A heater or a spirit-lamp
3. Ink and crushed ice

What to do ?

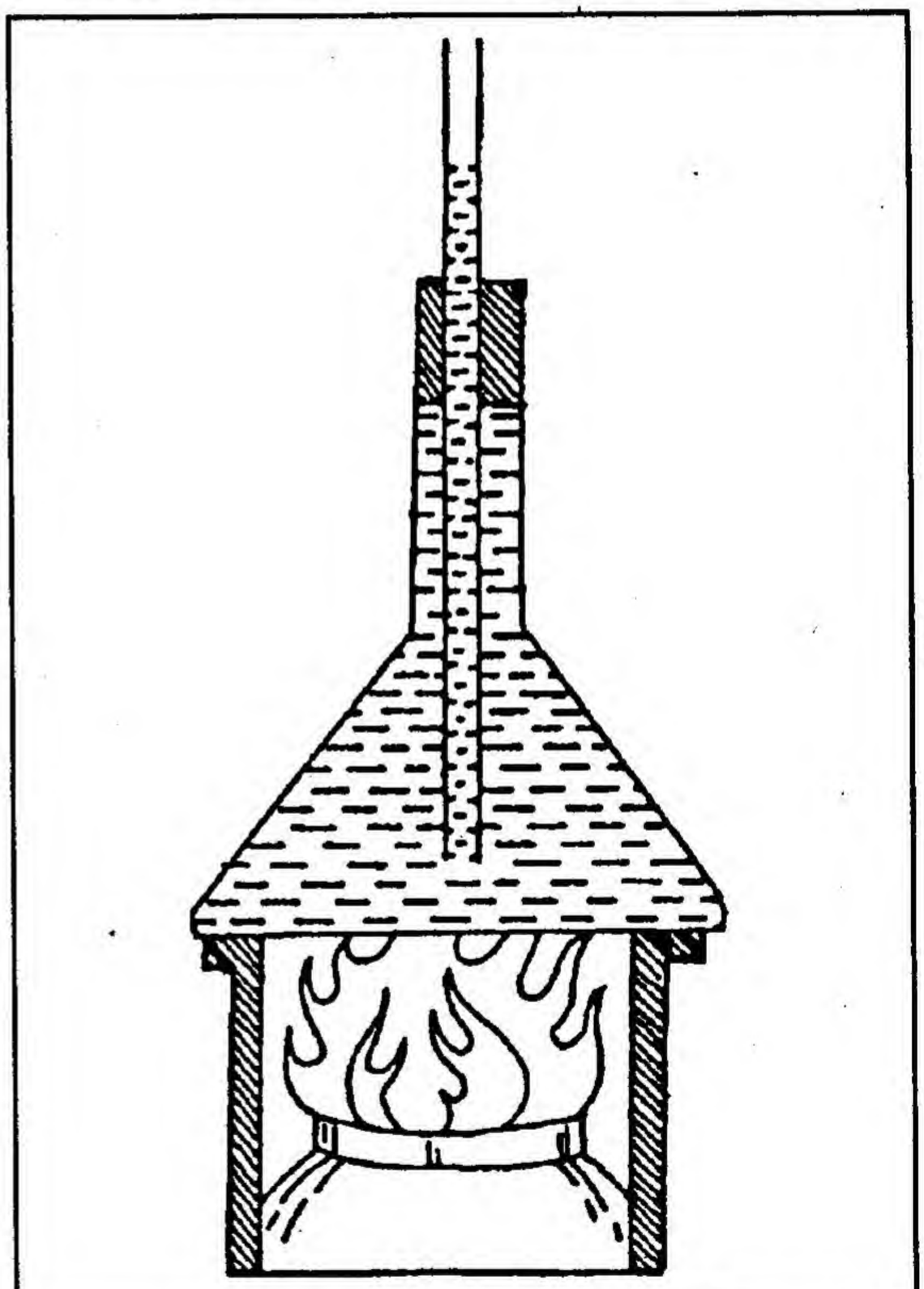
1. Fill the flask with coloured water. Close the mouth of the flask tightly with the stopper.
2. Heat the water in the flask. You will observe that the coloured water is rising in the tube. Be careful that air cannot enter the flask.
3. Now, keep the flask in crushed ice. You will observe that the coloured water in the tube is going down.

Students to enquire

1. Why do you have to stop entry of air inside the flask ?
2. Why is there a change in the height of water in the tube due to heating or cooling ?
3. Can you compare it with a real thermometer ?
4. How can you calibrate this improvised thermometer ?

Explanation

1. The flask has to be air tight so that when the water expands as a result of heating it cannot escape from anywhere except through the tube.
2. Most of the materials - solids, liquids or gases expand on heating and contract on cooling. As water cannot escape, it rises in the tube on heating and comes down on cooling.
3. It is an analogue of a thermometer.
4. To calibrate the thermometer keep the flask on crushed ice. You will observe that the water will start coming down and will stop at a certain height. Tie a rubber band to show the height. That will mark 0°C. Take out the flask from ice and after some time heat the flask for the water to boil. Water



will rise in the tube and stop at a particular height. Tie a rubber band to show that height. That marks 100°C. Now you may divide 0° to 100° at equal intervals. You have made your own thermometer.

57 Measuring temperature

Heat
Temperature

Materials

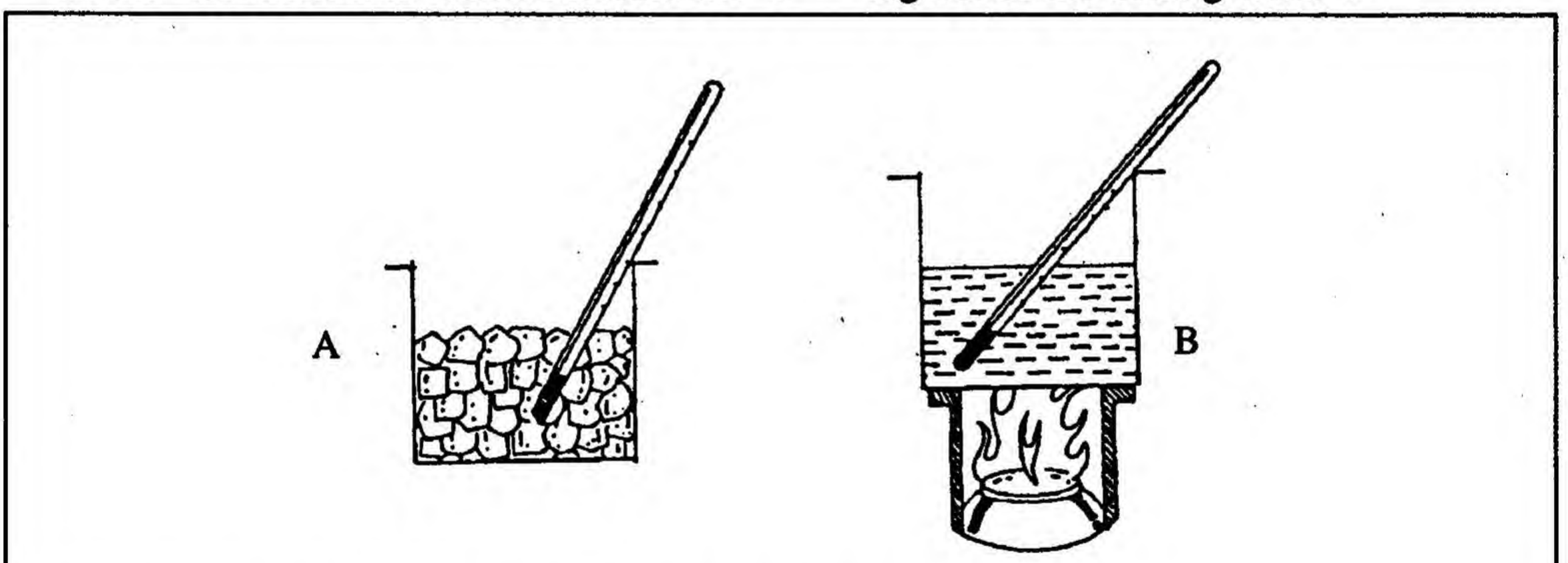
1. An alcohol thermometer
2. Ice cubes
3. A heater
4. A beaker

What to do ?

1. Take a few ice cubes in a beaker and introduce the thermometer into the ice cubes (fig.A). Observe what happens to the alcohol in the thermometer. Keep measuring the temperature at intervals of one minute till all the ice melts into water. Measure the temperature of the melted water after 10 or 15 minutes.
2. Now place the beaker with water on the heater (fig. B), insert the thermometer in water and heat it. Do not insert the thermometer in boiling water.
3. Observe what happens to the alcohol in the thermometer. Observe the temperature when the water starts boiling. Keep the water boiling for half a minute and observe what happens to the temperature.
4. Measure the temperature of the steam that comes out of the boiling water.

Students to enquire

1. When the thermometer is kept in the ice for some time, what is the temperature of ice?
2. What is the temperature of ice till it melts completely ?
3. What is the temperature of boiling water ?
4. What is the temperature of the melted water after it has been kept for some time ?
5. What is the temperature of the steam coming out of the boiling water ?



Explanation

1. When the thermometer is kept in the ice for some time it will show 0°C temperature.
2. As long as all the ice is not melted, the thermometer will show 0°C temperature.
3. The temperature of boiling water is 100°C.
4. When the melted water is kept for some time, the temperature gradually increases.
5. The temperature of steam coming out of boiling water is 100°C.

Heat
Melting Point

Melting point

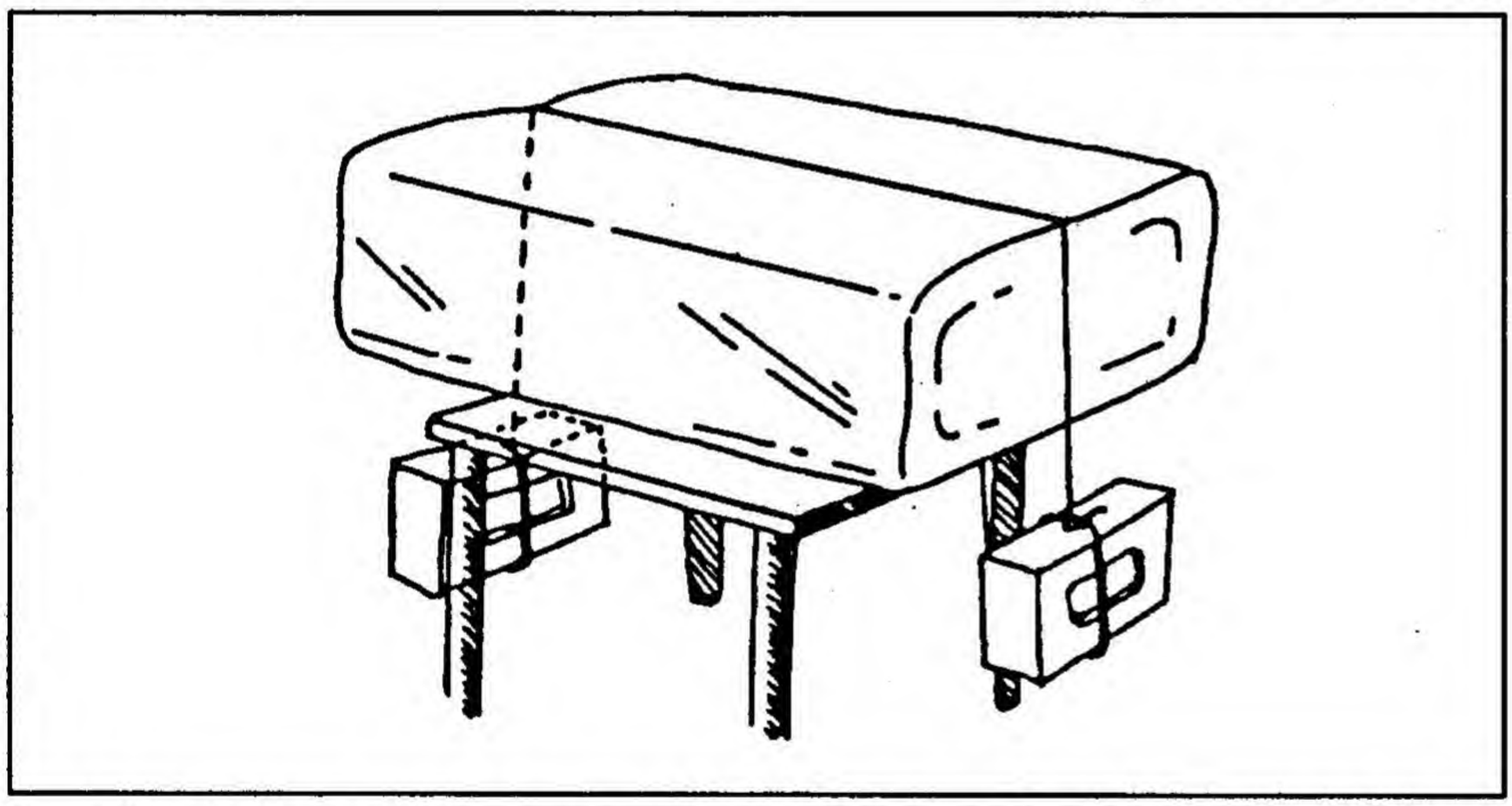
58

Materials

1. A big block of ice
2. A one meter long wire
3. Two bricks or heavy objects

What to do ?

1. Keep the block of ice on some object in such a way that its edges project outside.
2. Tie two heavy weights at the two ends of the wire and hang it in such a way that the wire passes through the centre of the ice block.



3. After some time you will observe that the wire has cut through the ice. But as the wire cuts through, the ice above the wire joins together.
4. When the wire cuts completely through the ice, it again joins together into one block.

Students to enquire

1. Why does the wire cut through the ice ?
2. What happened to the melted water above the ice ?
3. Which property of the ice is changed due to the pressure of wire on the ice ?
4. If the ice block is small, will the wire cut through the ice quicker ?
5. If the weights connected to the wire is increased, will the wire cut through the ice quicker ? If so, why ?

Explanation

1. The melting point of a solid is lowered when the pressure on it is increased. The wire exerts pressure on the ice. Hence the melting point of ice, where the wire exerts pressure on the ice, is decreased. For this the ice below the wire melts and the wire cuts through the ice.
2. After the ice melts because of the lowering of the melting point and the wire cuts through the melted water which is at 0°C the water freezes up again.
3. If pressure is increased on a solid, its melting point decreases.
4. If the block is small and the weight on the wire remains the same, then the wire will cut through quickly. For, in such a case pressure at a particular point will increase.
5. If the weight connected to the wire is increased, then the wire will cut through the ice quickly because pressure at a particular point will increase.

59

Increasing the boiling point

Heat
Boiling point

Materials

1. A small (100 c.c.) beaker
2. A thermometer and a spoon
3. A heater or a spirit-lamp

What to do ?

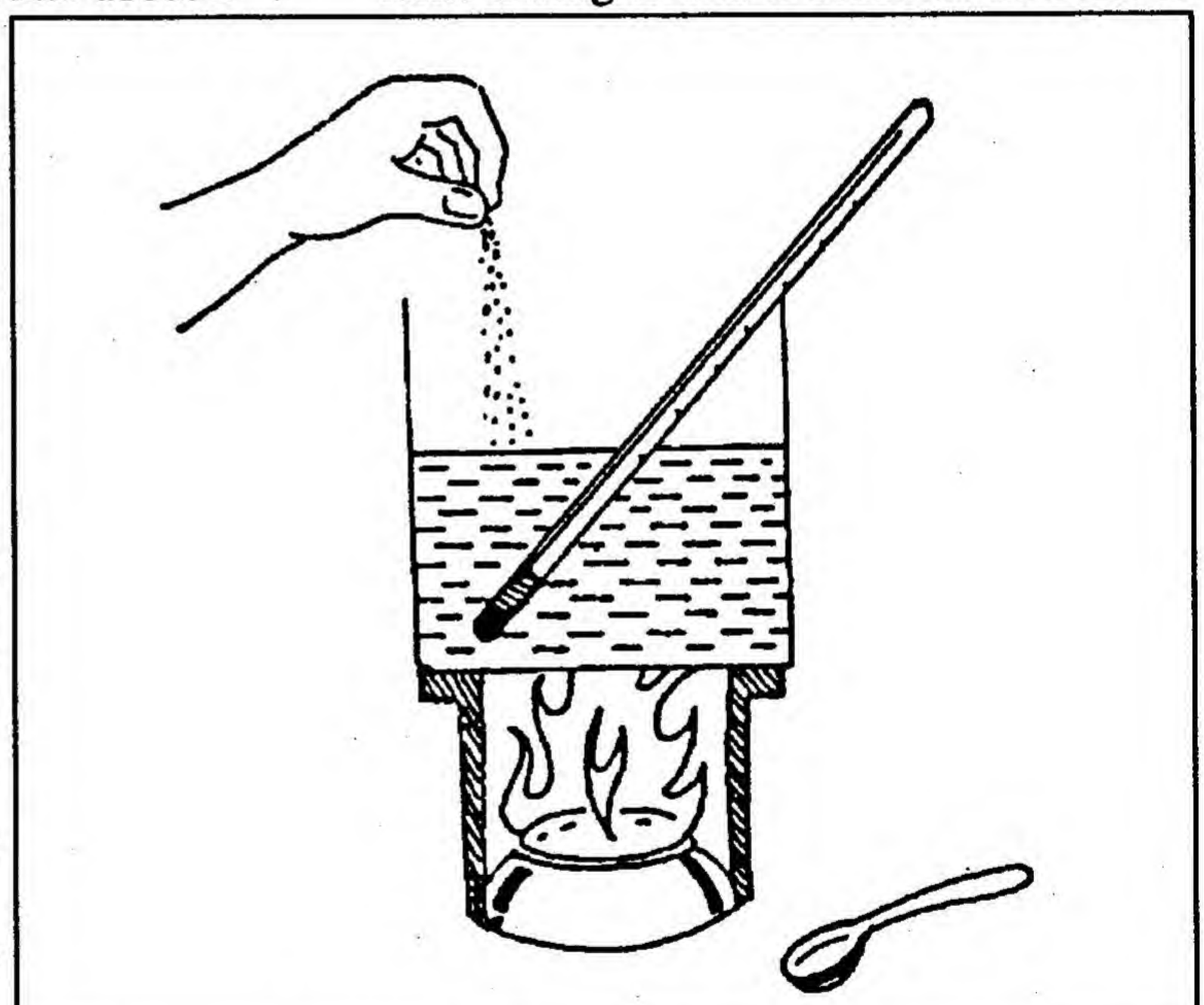
1. Heat about 2cc of water in a beaker. Measure the temperature of the water every half a minute and keep a note of it.
2. When the water starts boiling, mix about 2 gms. of salt with the water.
3. Continue heating the water and stir the water with the spoon. Note the temperature of water every half a minute till the water starts boiling.
4. Repeat the same experiment with 4 gms. and 6 gms. of salt.

Students to enquire

1. What is the boiling point of water at normal atmospheric pressure ?
2. After salt is mixed, what happens to the temperature of the solution ?
3. What is the boiling point of the solution ?
4. Why does the boiling point increase ?
5. What happens when you repeat the experiment with 4 gms. or 6 gms. of salt ?

Explanation

1. At ordinary pressure the boiling point of water is 100°C.
2. When salt is mixed with the water while it is boiling, the boiling stops and the temperature of water falls. Salt takes some heat from the water to melt. Because of this the temperature falls and the boiling stops.
3. The boiling point of the solution is increased.
4. Salt gets ionised in water. Water molecules keep together owing to cohesion. Water molecules attach also to sodium chloride ions. Owing to this it becomes difficult to conduct heat and the boiling stops. This causes the increase of the boiling point.
5. The more the salt, the more is the increase of the boiling point of the solution. But if the temperature of the steam coming out is measured, it will be 100°C.



Heat
Dew Point

Dew point

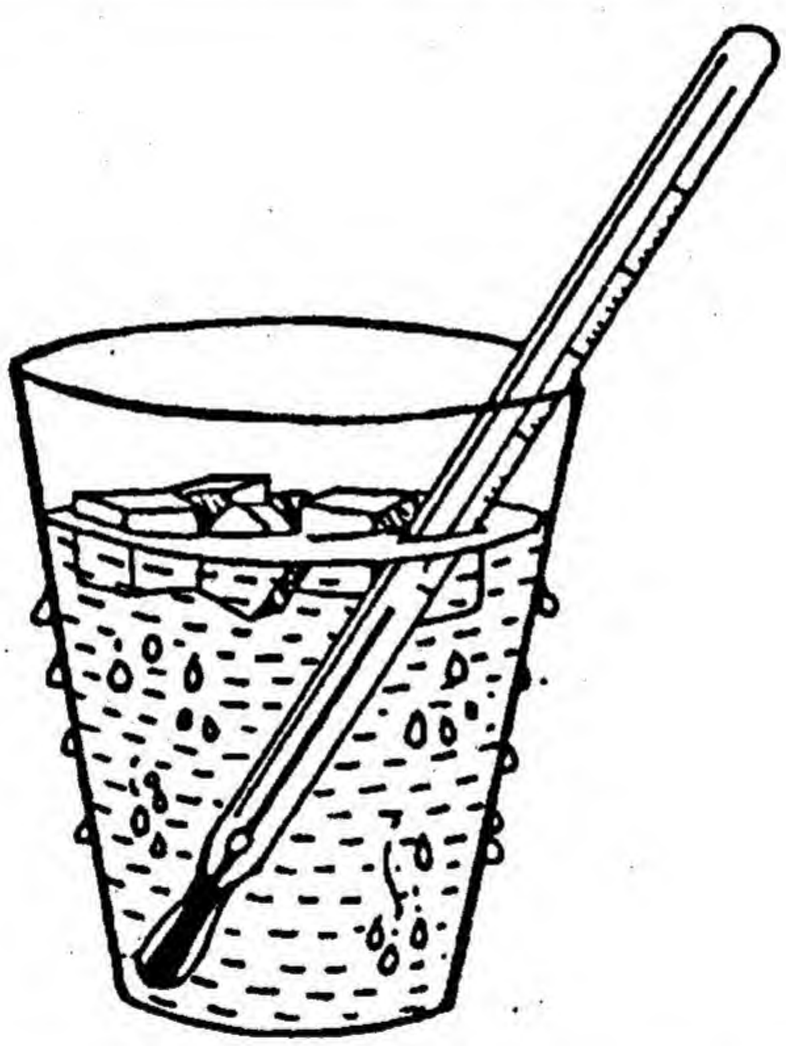
60

Materials

1. A glass tumbler and a spoon
2. A thermometer
3. Ice cubes and water

What to do ?

1. Take a glass of water and drop a few ice cubes in it. Keep a thermometer in the water and note the temperature at regular intervals.



2. Observe the outside of the glass carefully.
3. Stir the water with the spoon and observe at what temperature the dew appears outside the glass.

Students to enquire

1. From where does the dew come on the outside of the glass ?
2. At what temperature is the dew formed ?
3. Will the dew point be higher or lower if the humidity in the air is low ?
4. Where do we find a similar event in our daily life ?

Explanation

1. Dew comes from the air. Ice cools the glass. So, the water vapour in the atmosphere gets condensed into water droplets when it comes in contact with the cool glass.
2. If the dew point is measured in different seasons at different periods of the day or the year, it will be observed that the dew point will be different.
3. The drier the air, the lower is the dew point.
4. In winter we observe that dew forms on the grass early in the morning. In the night the earth cools and when the water vapour in the air comes in contact with the cool earth, it condenses into water droplets.

61 Salt lowers freezing point

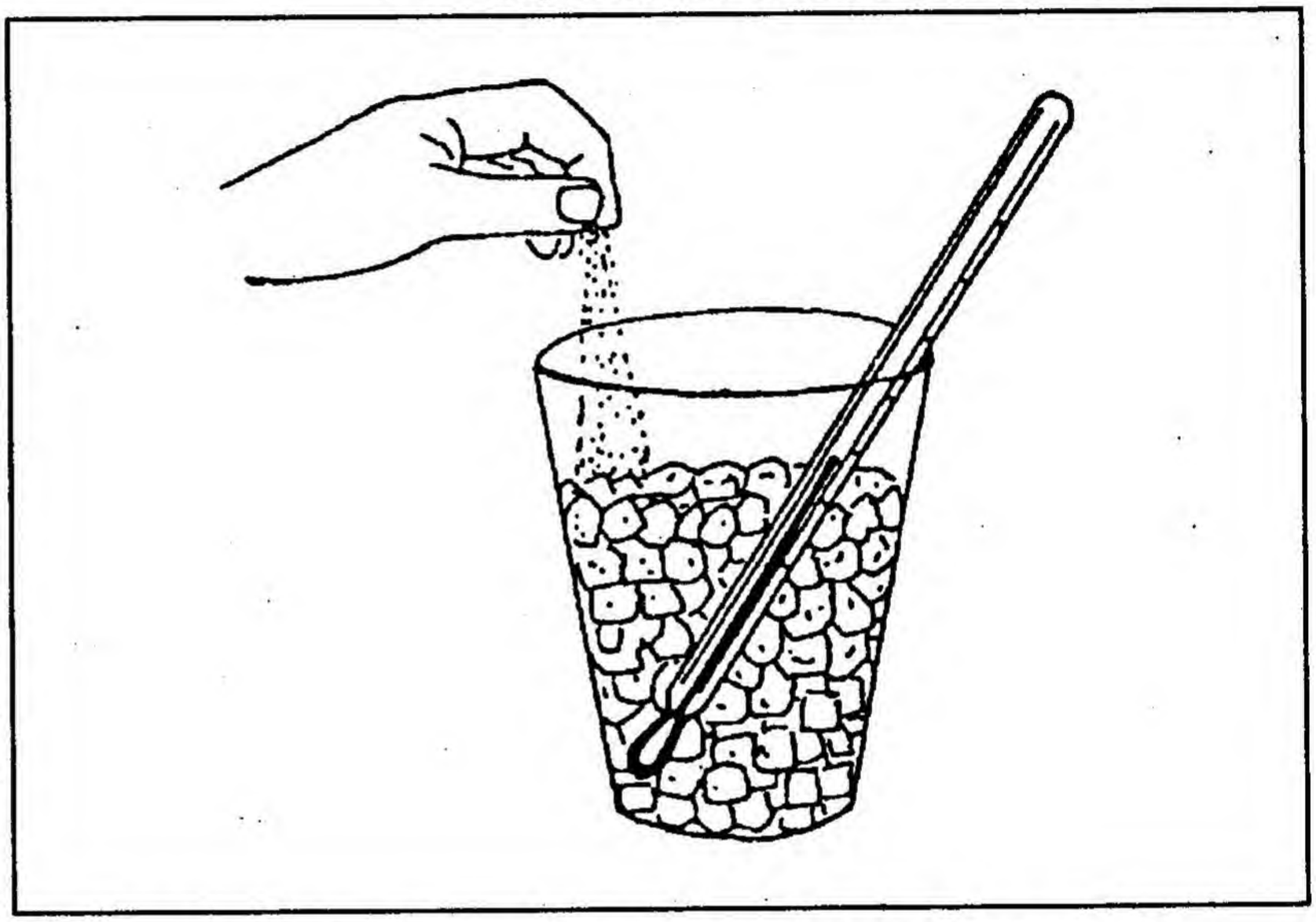
Heat
Freezing Point

Materials

1. A cup
2. A thermometer (-10°C to 50°C)
3. Salt
4. Ice

What to do ?

1. Fill the cup with ice cubes and insert a thermometer in the ice. Crushed ice will be better.
2. You will observe that after some time the thermometer will show 0°C temperature. The thermometer will not go down further, no matter how long you keep the thermometer in the ice.
3. Now, mix salt with the ice and stir the mixture. Notice the thermometer reading. You will observe that the temperature will go down to about -10°C. Some of the ice will melt quickly.



Students to enquire

1. Normally, at what temperature does ice melt ?
2. Why does ice melt when you mix salt with it ?
3. When ice melts on addition of salt, is heat added or extracted ?
4. Is heat added or extracted while the experiment is conducted ?

Explanation

1. Normally, ice melts at 0°C.
2. The melting or freezing point of ice and salt solution is always lower than pure water. So, when salt is mixed, the ice melts at 0°C as the freezing point gets lowered.
3. Ice needs heat to melt. But as no heat has been aided to the ice from outside, it extracts heat from its environment to melt. A similar event occurs when water is kept in an earthen pitcher. Water oozes through the pores of the pot and evaporates. To evaporate water extracts heat from the pot and itself. Hence the water in an earthen pitcher is cool during summer.
4. In this experiment no heat has been supplied from outside. Heat has been extracted from the ice itself.

Heat

Cooling by blowing air

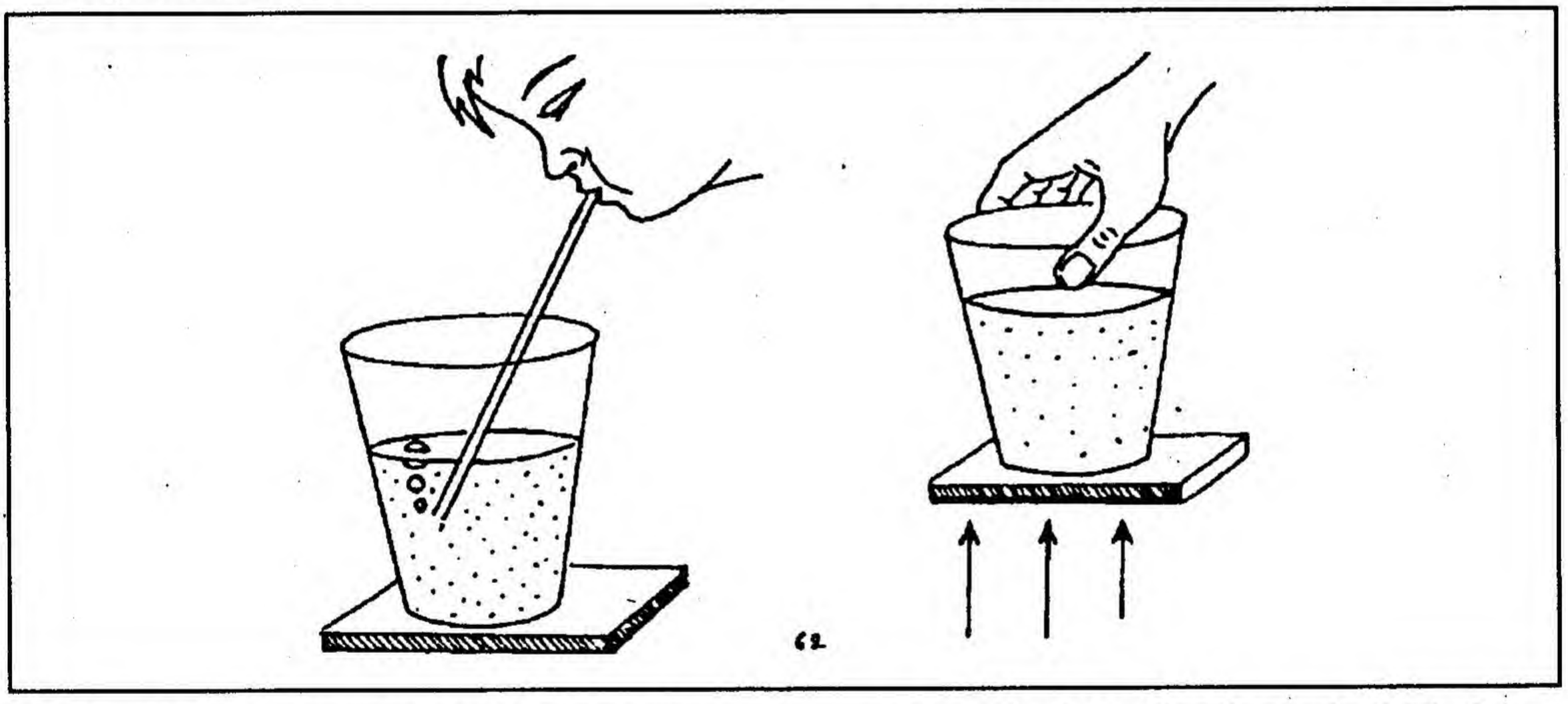
62

Materials

1. Ether or alcohol
2. A straw
3. A thin steel glass
4. A thin wooden board

What to do ?

1. Wet the wooden board with water.
2. Take a little ether or alcohol in the glass and keep it on the wooden board.



3. Now insert a straw in the liquid and keep blowing air through it. You will observe that bubbles will come up through the ether.
4. After blowing for a while, you will observe that the glass has become very cool and it has stuck to the board. If you raise the glass the board also will come up with it.
5. If you wet the board with coconut oil,then the experiment will work better.

Students to enquire

1. Why does the glass get cooled when you blow air through the alcohol or ether ?
2. Why does the glass get stuck to the board ?
3. Why does the experiment work better with coconut oil ?

Explanation

1. When the air is blown through the alcohol or ether, it gets evaporated quickly. For evaporation latent heat is required. The latent heat is taken away from the ether or alcohol and glass. Because of this the liquid and the glass get cooled.
2. When the glass becomes too cold, the water in the board below the glass gets cooled and forms ice. For this the glass gets stuck to the board.

■ **Be careful : Ether or alcohol is highly inflammable.** ■

63 The wind cools

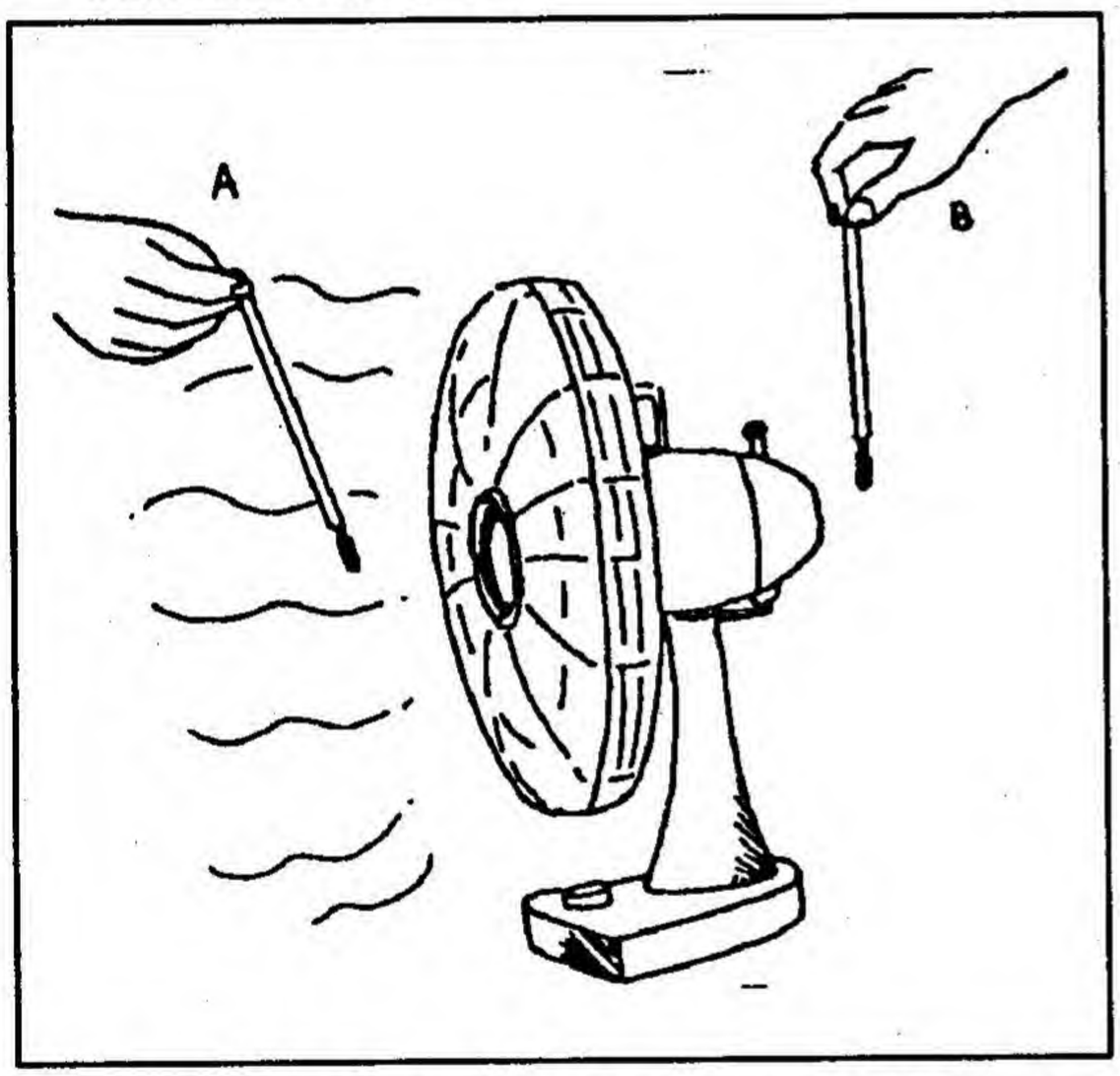
Heat

Materials

1. A table fan
2. Two alcohol thermometers

What to do ?

1. Note the temperatures recorded by the thermometers.
2. Keep the thermometer A in the wind in front of the fan. Keep the thermometer B at the back of the fan.



3. Keep the fan blowing for some time and then mark the temperatures recorded by both the thermometers. You will observe that both the thermometers show the same reading.
4. Now wrap the bulb of the thermometer A with a wet cloth and switch on the fan. If the temperature is measured after a few minutes you will observe that the temperature recorded by the thermometer A is less than that recorded by thermometer B.

Students to enquire

1. When the fan is turned on before the bulb of the thermometer A has been covered with the wet cloth, why is there no difference between the temperatures recorded by the two thermometers ?
2. When the bulb of the thermometer A is wrapped with the wet cloth, why does it record a lower temperature ?
3. Why do we feel cool when the air blows ?

Explanation

1. Apparently, it might seem that when air blows, the thermometer A should reach a lower temperature. But if the temperature is measured by a sensitive thermometer, then the thermometer A will record a little higher temperature. The temperature in thermometer A will rise because of friction between the thermometer bulb and the blowing air.
2. But when the bulb is wrapped with the wet cloth, water evaporates from the cloth. For evaporation heat is taken away from the bulb. When air blows from the fan, the saturated air round the bulb is driven away. Hence a lower temperature is shown by the thermometer A.
3. When the air blows, sweat evaporates more quickly. Hence we feel cool. During the summer when the air is humid, the air round our body remains saturated with water vapour. Then the evaporation of sweat from the body stops. Hence we feel uncomfortable. But. if the air blows, the saturated air is driven away. More evaporation of sweat takes place and we feel comfortable.

Heat

Lifting an ice cube with thread

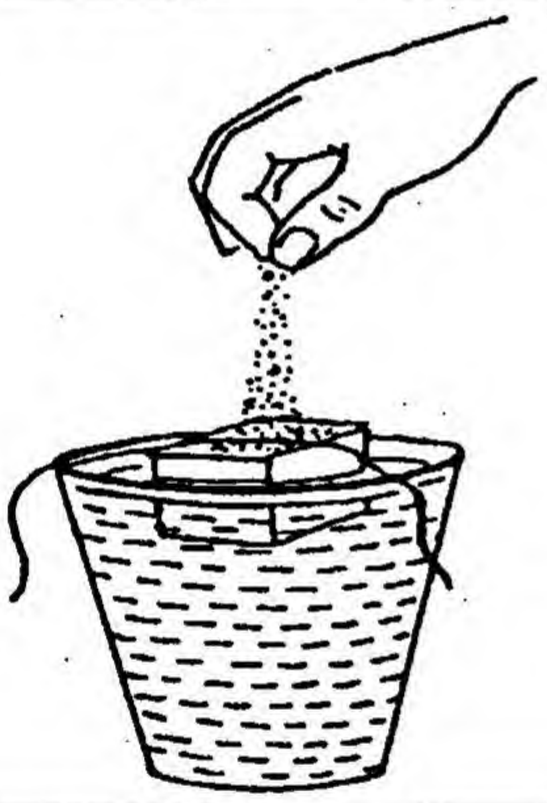
64

Materials

1. An ice cube
2. Salt
3. A long thread

What to do ?

1. Keep the ice on the table and place a thread along the centre line of the ice cube.
2. Sprinkle some salt on the thread.
3. After a little while try to raise the thread carefully. You will observe that the ice cube



will come up along with the thread.

4. You will observe that the ice has melted at the place where the salt is sprinkled. But the melted water will solidify into ice again after a while.

Students to enquire

1. At what temperature does the ice melt ?
2. How could you lift the ice cube ?
3. Where in our daily life do we use the property of lowering the melting point of ice with the help of salt ?
4. In cold countries when the road is covered with snow, salt is sprinkled on the road, why?

Explanation

1. Ice melts at 0°C.
2. The melting or freezing point of saline water is less than pure water. Hence, when salt is sprinkled, the ice around the thread melts.The temperature of melted water is less than 0°C When a considerable quantity of ice melts, the concentration of salinity of water reduces. For this the freezing point of the solution comes near to 0°C. But as the temperature of the water is then a few degrees below 0°C it freezes again and the thread gets stuck to the ice.
3. When ice cream is made at home, a temperature lower than 0°C is achieved by mixing salt with the crushed ice. Owing to this the liquid mixture that makes the ice cream freezes easily.
4. In cold countries when ice is formed on the roads during winter time it becomes difficult to drive a car. The car skids while moving. When the car moves on ice it exerts pressure on the ice. We know that the freezing point of water goes down with increased pressure. Because of this, the ice below the tyres melts, the road becomes slippery and the car skids. To avoid skidding salt is sprinkled on the ice. Salt lowers the temperature of ice below 20°C. Hence, when a car moves on the ice, though the freezing point of water goes below 0°C the ice does not melt as its temperature is already much below 0°C because of the sprinkling of salt.

65

Heat changes state of matter

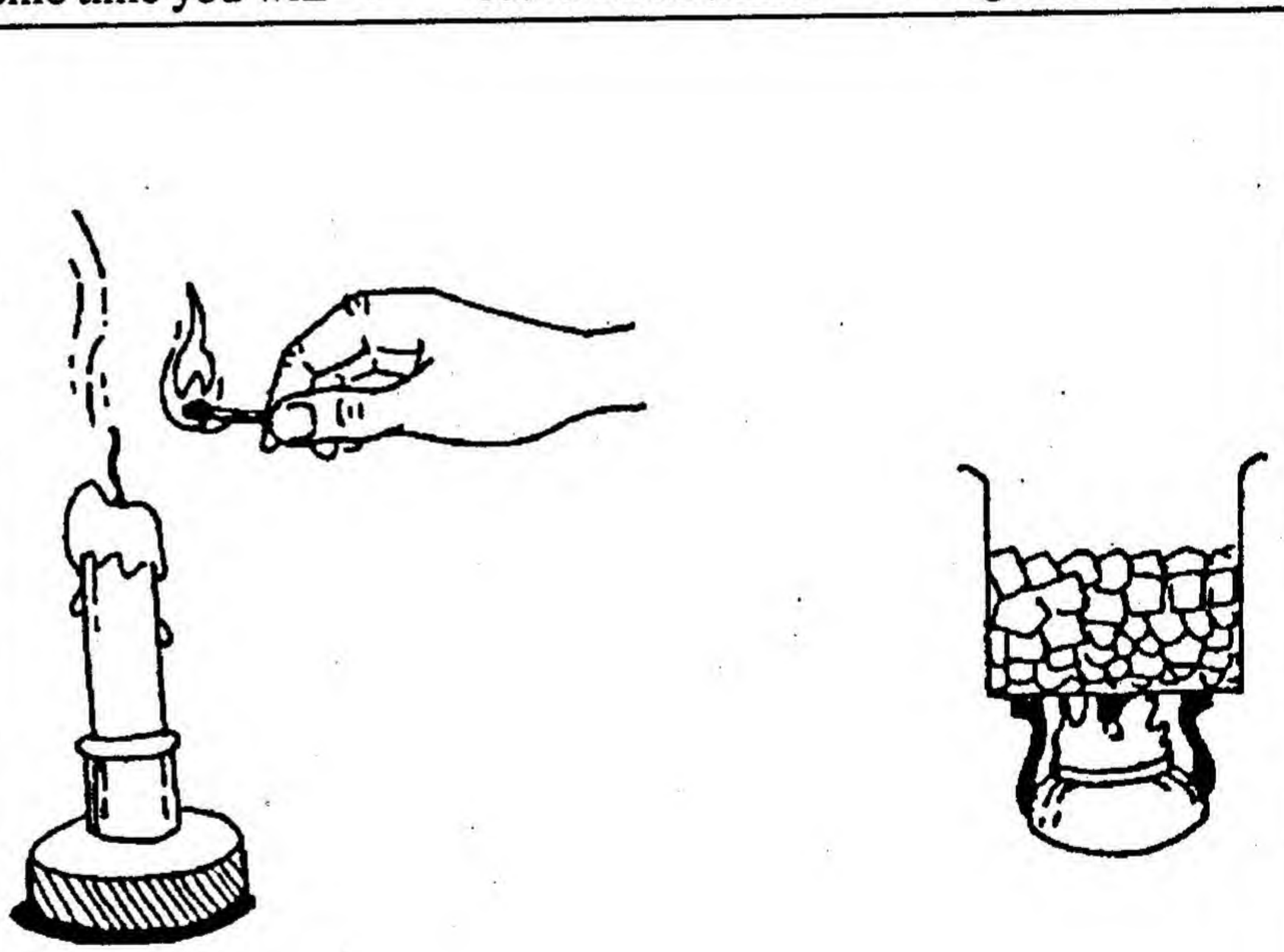
Heat

Materials

1. Matches
2. Ice cubes
3. A small beaker(100cc)
4. A spirit lamp or a heater
5. A candle

What to do ?

1. Light the candle. You will observe that wax will start melting. After some time you will observe that gas is coming out of the molten wax.
2. Blow off the candle. You will observe that the gas is coming out. Bring a lighted matchstick near the gas. You will observe that the candle will catch the flame.
3. Take a small piece of ice in a beaker and heat it. You will observe that the ice will melt into water and after some time water will convert into steam.



Students to enquire

1. What do you understand by the melting and gasification of wax by heat ?
2. Why does the candle burst into flame when you bring a lighted matchstick near it when it has just been put out ?
3. What do you infer from the melting of ice into water and the formation of steam due to heat ?

Explanation

1. From the melting of wax and formation of gas one can understand that heat changes the state of matter.
2. After a candle is put out, wax gas comes out for some time .When a lighted matchstick is brought near this gas, it is ignited and the candle bursts into flame.
3. The change of ice into water and then into steam proves that heat changes the state of matter. It also shows that matter has three states – solid, liquid and gaseous.

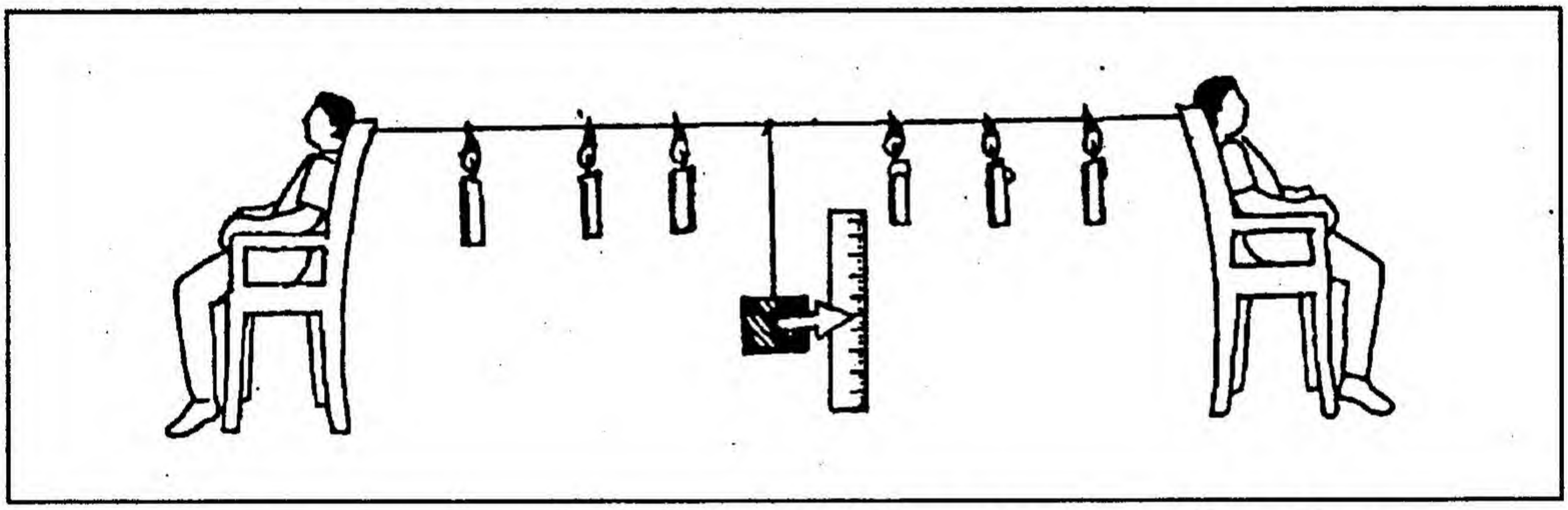
Heat

Heat expands matter

66

Materials

1. A 3 m. long iron wire
2. A 500 gm. weight
3. A scale
4. Matches
5. Six candles
6. Two chairs
7. A paper arrow
8. A clip or a little cellotape



What to do ?

1. Tie the wire to the chairs and keep it taut. Ask two of your friends to sit on the chairs.
2. Hang the weight with a string from the middle of the wire. Attach the paper arrow to the string or the weight with the clip or the cellotape respectively so that it may show height on the scale.
3. Now, ask your friends to heat the wire at different places with the lighted candles. You will observe that the arrow will gradually go down.

Students to enquire

1. Why will the arrow go down ?
2. Will there be any change in the amount of lowering of the arrow if the numbers of candles are changed ?
3. Will the amount of lowering depend upon the material of the wire ?
4. Give some examples of expansion by heat from your daily experience.

Explanation

1. When you heat the wire, it expands in length. Hence the arrow will go down.
2. The wire will extend more if the number of candles are increased. The arrow will go down.
3. Different materials expand differently with the same amount of heat. Copper will expand more.
4. To prevent the railway lines from buckling, a small gap is left between two successive rails to allow for expansion of the lines when heated. The same precaution is taken when placing steel bands round cartwheels.

67 Heat fountain

Heat

Materials

1. A 50 c.c. pipette
2. A glass tumbler
3. A heater

What to do ?

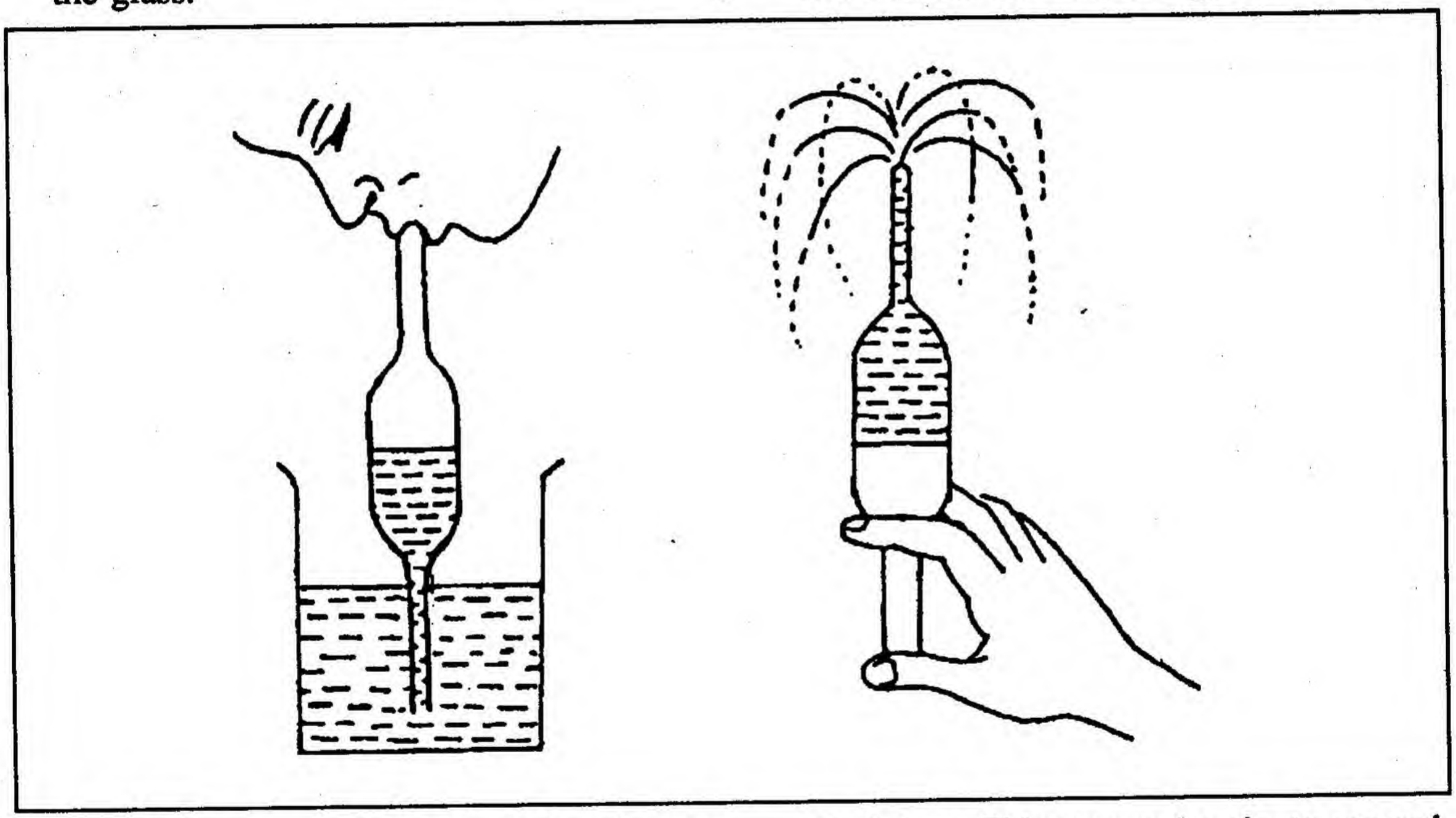
1. Heat some water and take the hot water in the glass.
2. Draw by mouth the hot water in the pipette (half of it).
3. Then close the open end with your thumb and quickly draw out the pipette from the hot water and invert it.
4. You will observe that hot water comes out of the nozzle end like a spray.
5. Invert the pipette slowly and observe what happens.

Students to enquire

1. Why does the water come out like a spray ?
2. Why is it that the water does not come out like a spray when you invert the pipette slowly ?

Explanation

1. When the pipette is suddenly inverted and hot water starts descending, it heats up the air below. This causes the air to expand. This expanding air exerts increased pressure on the falling hot water. So the hot water comes out like a spray.
2. When you invert the pipette slowly, the air does not get trapped. Hence a higher pressure is not created to force the water out.



Heat
Environment

Wind current

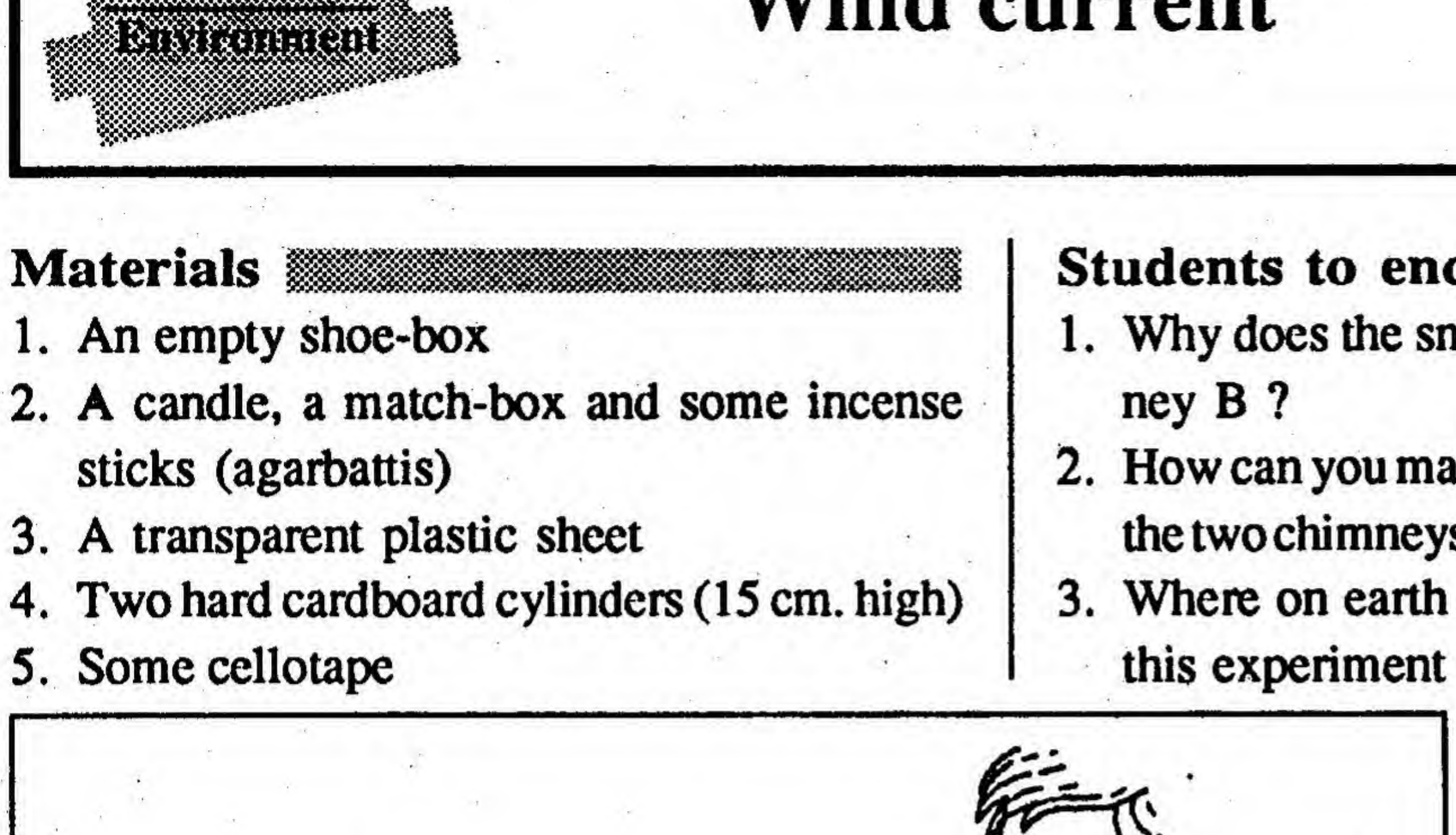
68

Materials

1. An empty shoe-box
2. A candle, a match-box and some incense sticks (agarbattis)
3. A transparent plastic sheet
4. Two hard cardboard cylinders (15 cm. high)
5. Some cellotape

Students to enquire

1. Why does the smoke come down the chimney B ?
2. How can you make the air circulate between the two chimneys without the lighted candle?
3. Where on earth do we find an example of this experiment ?



What to do ?

1. Cut open one long side of the shoe-box and cover it with the plastic sheet so that the inside may be visible. Fix the two cylinders on the top of the box as shown in the figure.
2. Place the candle first below the chimney A and light the candle. If there is any opening cover it with cellotape.
3. Light two incense sticks and hold them over the chimney B. Do not hold the sticks just above the chimney. Blow the incense smoke near the chimney B. Observe how the smoke travels.

Explanation

1. The air around the lighted candle gets warm, becomes light and rises up the chimney A. Owing to this a partial vacuum is created inside the box. This causes the incense smoke to enter through the chimney B into the box to fill up the vacuum. A draught is created inside from chimney B to chimney A and the smoke goes up the chimney A.
2. If we hold an ice cube over the chimney B, then the air round it becomes heavy and will go down the chimney B and a wind current will be created.
3. In the daytime the land gets heated and the light air goes up creating a partial vacuum. Cool air from the sea rushes towards the land creating an air current. In the night the land becomes cool quicker than the sea. Then the cool air from the land blows towards the sea.

69

Change of seasons

Heat
Weather

Materials

1. A powerful torch
2. A dark room

What to do ?

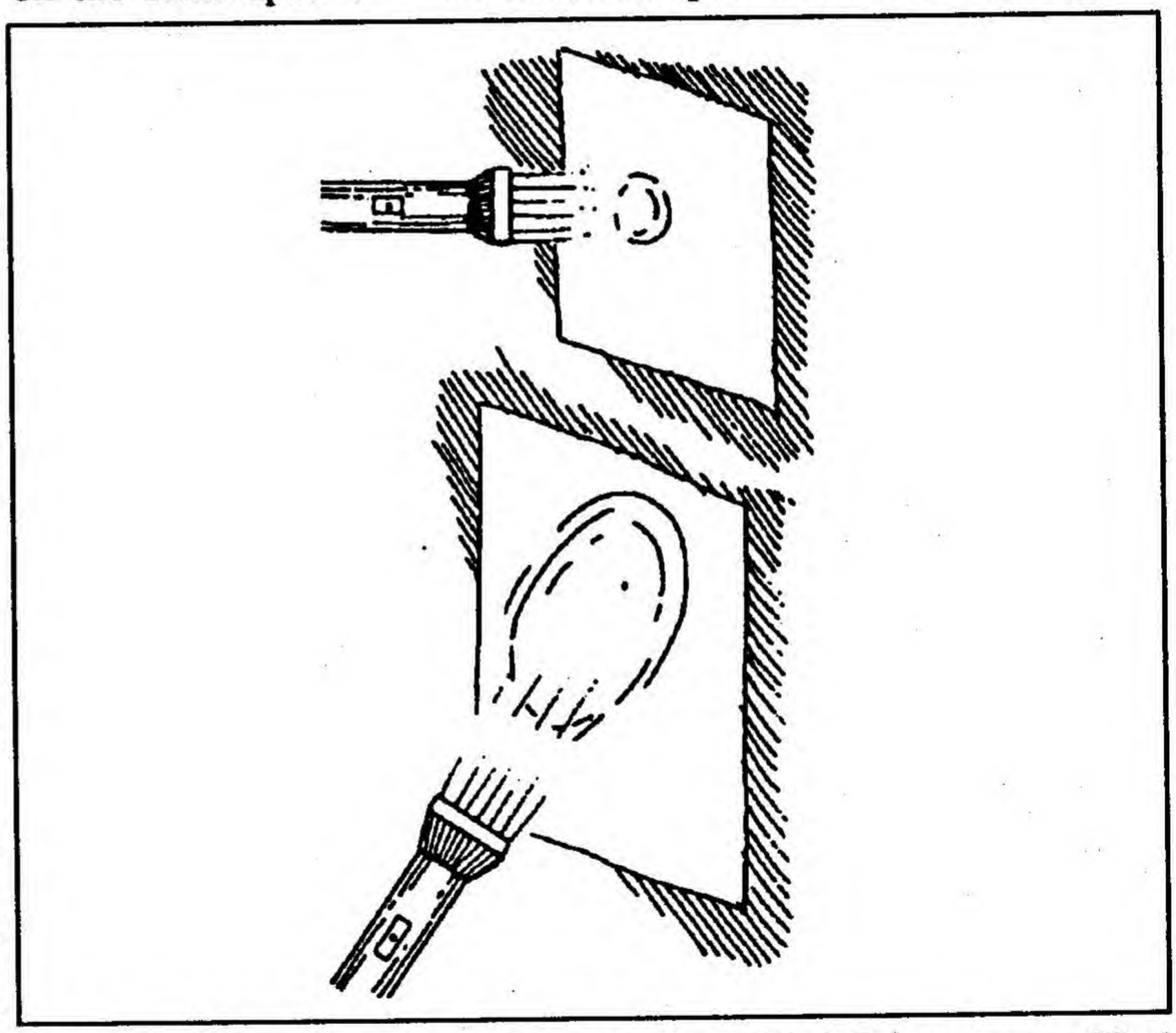
1. Focus the torchlight straight on the wall and notice the brightness of the spot of light.
2. Now throw the light on the same spot obliquely. You will observe that the light gets spread over a wider area and the brightness per unit area has decreased.

Students to enquire

1. Why does the brightness differ when the light falls on the wall obliquely ?
2. What relationship is there between this experiment and the change of season ?

Explanation

1. The amount of light energy coming out of the torch remains the same whether it falls straight or obliquely on the wall. But when the light falls slantingly it is distributed over a wider area. Hence the amount of light per unit area is less. Because of this the brightness is decreased when light falls slantingly.
2. When the earth resolves round the sun, the same phenomenon occurs . The axis of earth is at an angle of $66^1/_2°$ with the ecliptic plane. From 22nd March to 23rd September the sunlight falls at right angles on different latitudes on earth upto $23^1/_2°$ N. Hence the northern hemisphere has summer during this period. But from 23rd September to 22nd March the sunlight falls at right angles on different latitudes in the southern hemisphere. During this period the southern hemisphere has summer and in the northern hemisphere where the sunlight falls obliquely is winter.



Magnetism

Magnetic and Non-magnetic substances

70

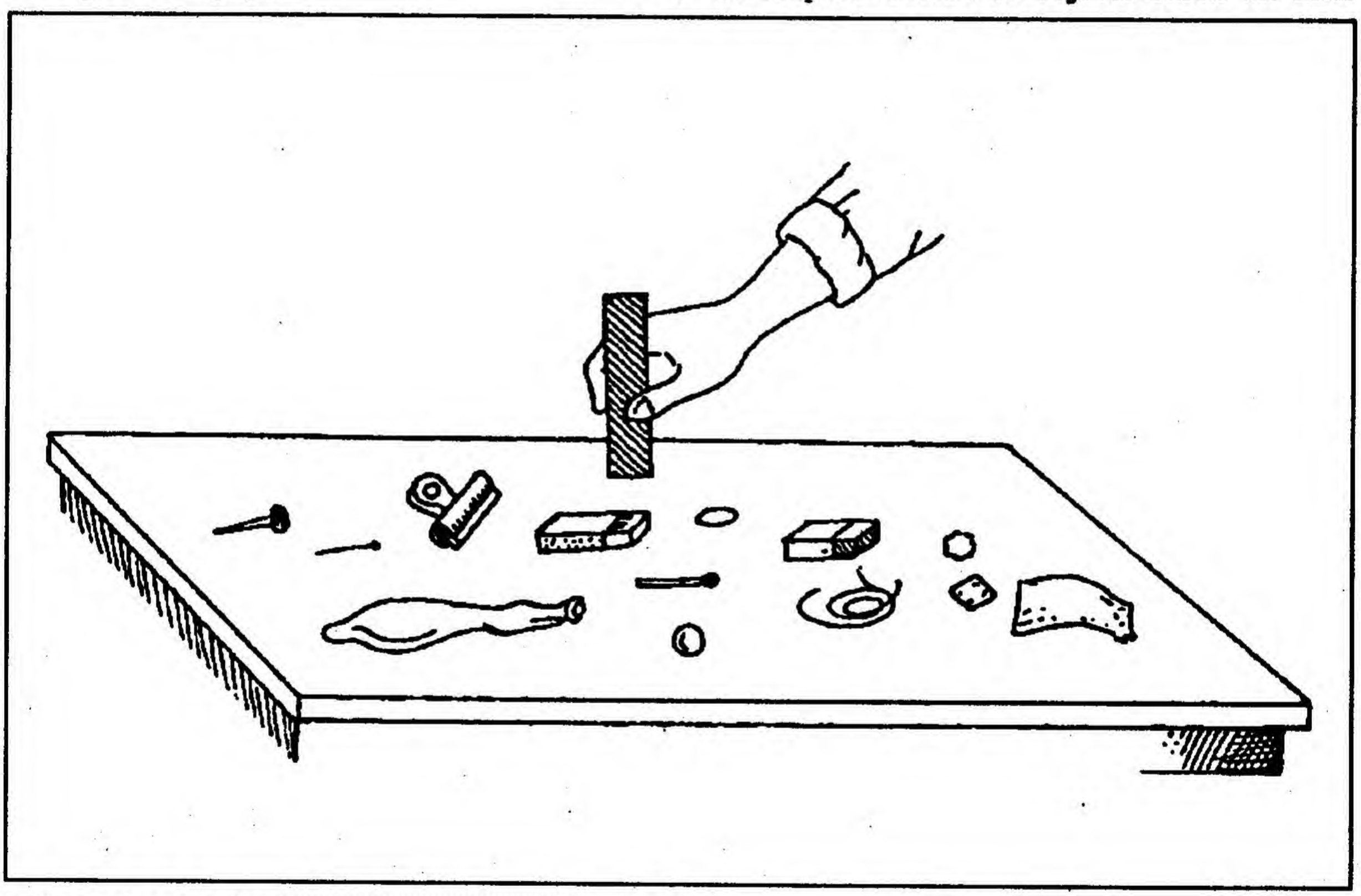
Materials

1. A bar magnet
2. Different materials; a nail, a pin, a piece of rubber, a balloon, a piece of chalk, a piece of copper wire, a piece of aluminium foil, a matchstick, a marble, a 10 paise coin and a piece of paper

not attracted by the magnet.

Students to enquire

1. What are the names of the objects that are attracted by the magnet ?
2. What are the names of the objects that are not attracted by the magnet ?
3. Prepare a table of objects based on their magnetic properties.



What to do ?

1. Spread the objects on the table. Touch each object with the magnet one by one.
2. Keep the objects which are attracted by the magnet at one side in a row. Lay on the other side another row of objects which are

Explanation

1. The objects which are attracted by the magnet are called magnetic substances.
2. The objects which are not attracted by the magnet are called non-magnetic substances.

71 Magnet attracts

Magnetism

Materials

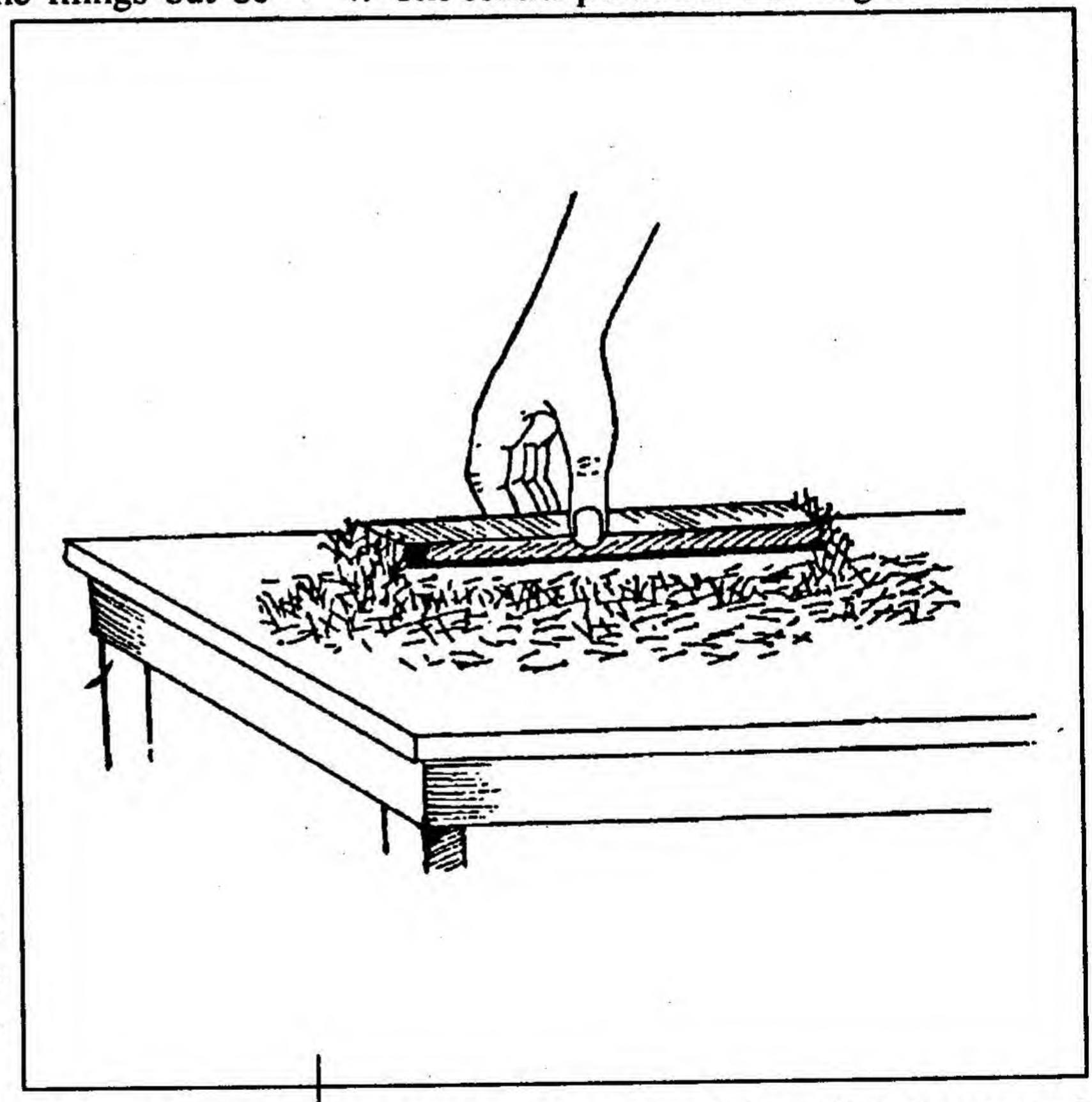
1. A bar magnet
2. Iron filings

What to do ?

1. Take some iron filings on a picce of paper and spread it evenly.
2. Bring the magnet over the filings but be careful not to touch them. Observe where in the magnet the filings are attracted most.
3. The experiment works well if the bar magnet is long (4"-6") and is weak.

Students to enquire

1. Where do most of the filings accumulate on the magnet ?
2. In which portion practically no iron filings are attracted ?
3. What are the ends where most of the iron filings are collected called ?
4. What is the name of that portion of a magnet where no iron filings are attracted ?
5. Which property of a magnet is understood by this experiment ?



Explanation

1. Most of the filings are attracted at the ends of a magnet.
2. In the middle portion practically no iron filings are attracted. If the bar magnet is weak and long, the effect can be seen much better.
3. The ends where the attraction is the maximum are called the poles of a magnet.
4. The central portion of the magnet where no filings are attracted is called the neutral zone.
5. The attractive property of a magnet is undctstood by this experiment.

Magnetism

Find the poles of a magnet

72

Materials

1. A long bar magnet
2. A bent copper piece tied to a string

What to do ?

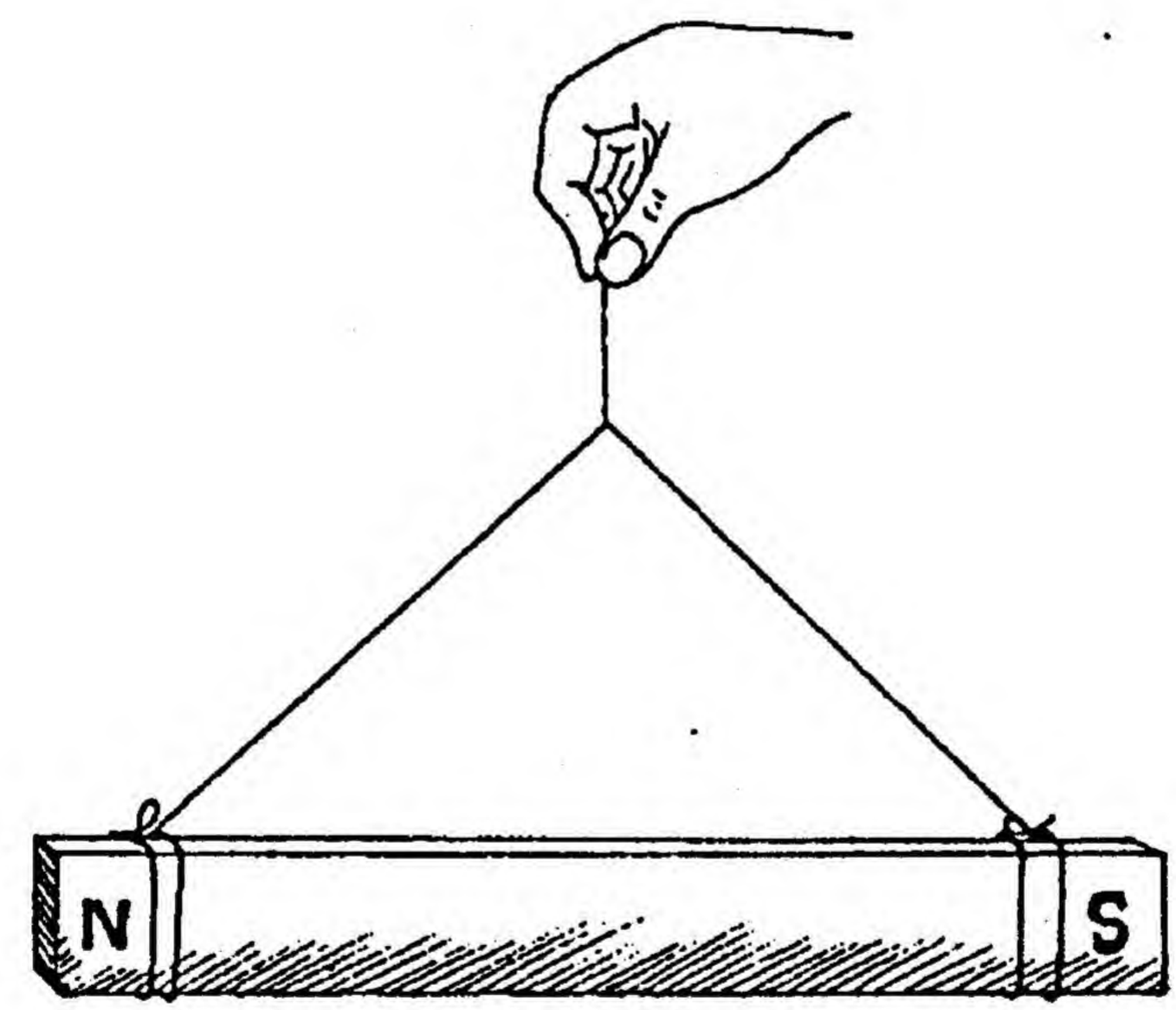
1. Place the bar magnet on the bent copper piece and allow it to hang horizontally by holding the string.
2. Observe that the magnet swings and then it shows the north-south direction when it comes to rest.
3. Swing the magnet slightly and observe that it again shows the north-south direction.
4. Now, reverse the magnet and hang it. You will see that the magnet again turns and shows the north-south direction.

Students to enquire

1. Why does the magnet come to show the north-south direction every time ?

Explanation

1. Earth behaves as a big magnet with its poles situated near the geographical north and south. The magnetic field of the earth aligns the hung magnet in the north-south direction. The end which points towards the north is designated the north pole and the other end, the south pole.



73 Magnet shows direction

Magnetism

Materials

1. A bar magnet
2. A magnetic needle

What to do ?

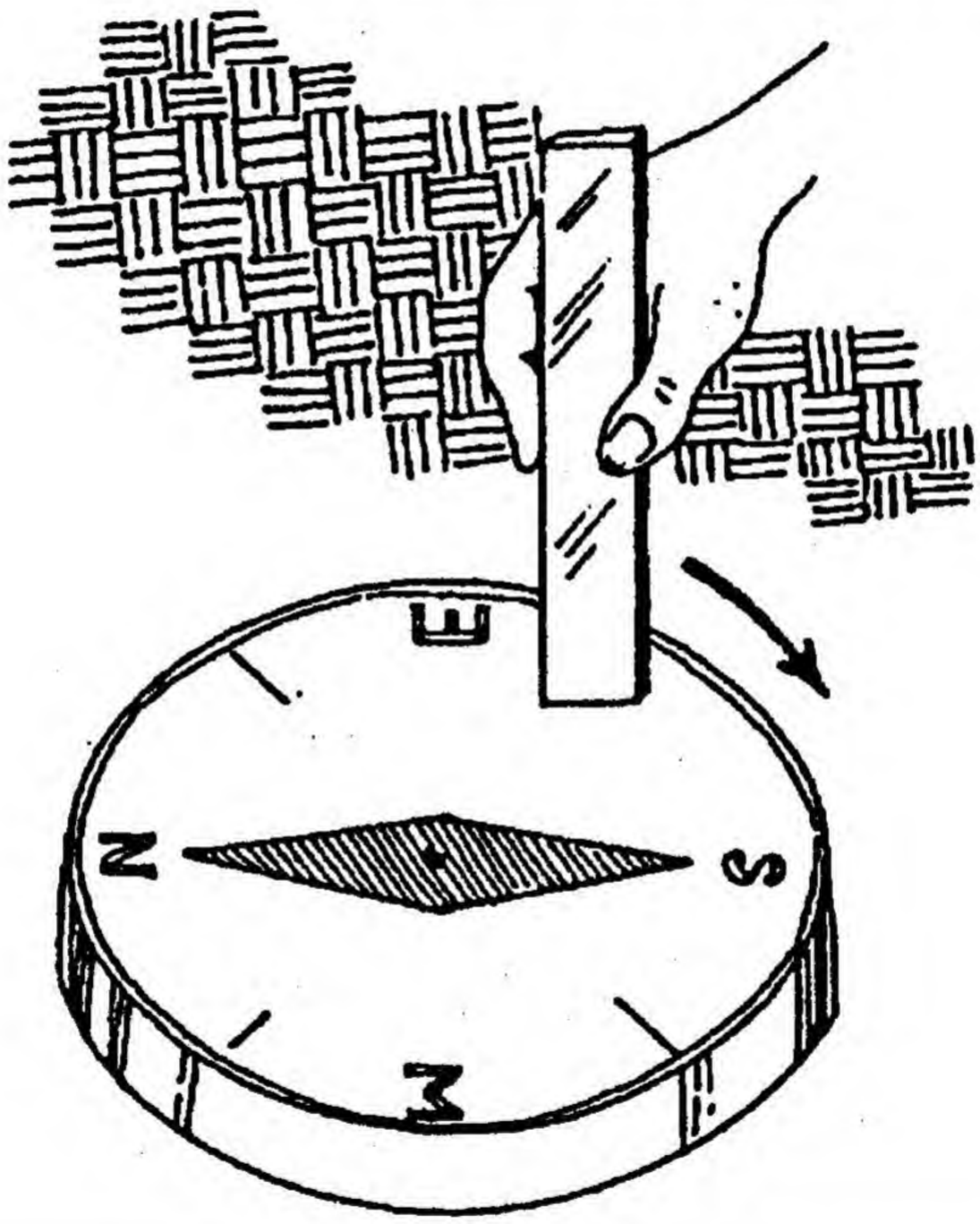
1. Keep the magnetic needle on the table. When the needle comes to rest observe the direction the needle shows.
2. Keep the bar magnet about 15 cm. above the needle and rotate it so that the needle starts rotating.
3. Stop the rotation of the needle and observe the direction the needle shows.

Students to enquire

1. To which direction does the needle point ?
2. Why does the needle point to the same direction ?

Explanation

1. The needle always points towards the north-south direction.
2. A needle is a very feeble magnet which can move freely on a pivot. The earth behaves like a huge bar magnet. The earth's magnetic field aligns the magnetic needle in the north-south direction. The end of the needle which points towards the geographical North is called the North pole and the other end which points southwards is called the South pole.



Magnetism

Magnetic attraction & repulsion

74

Materials

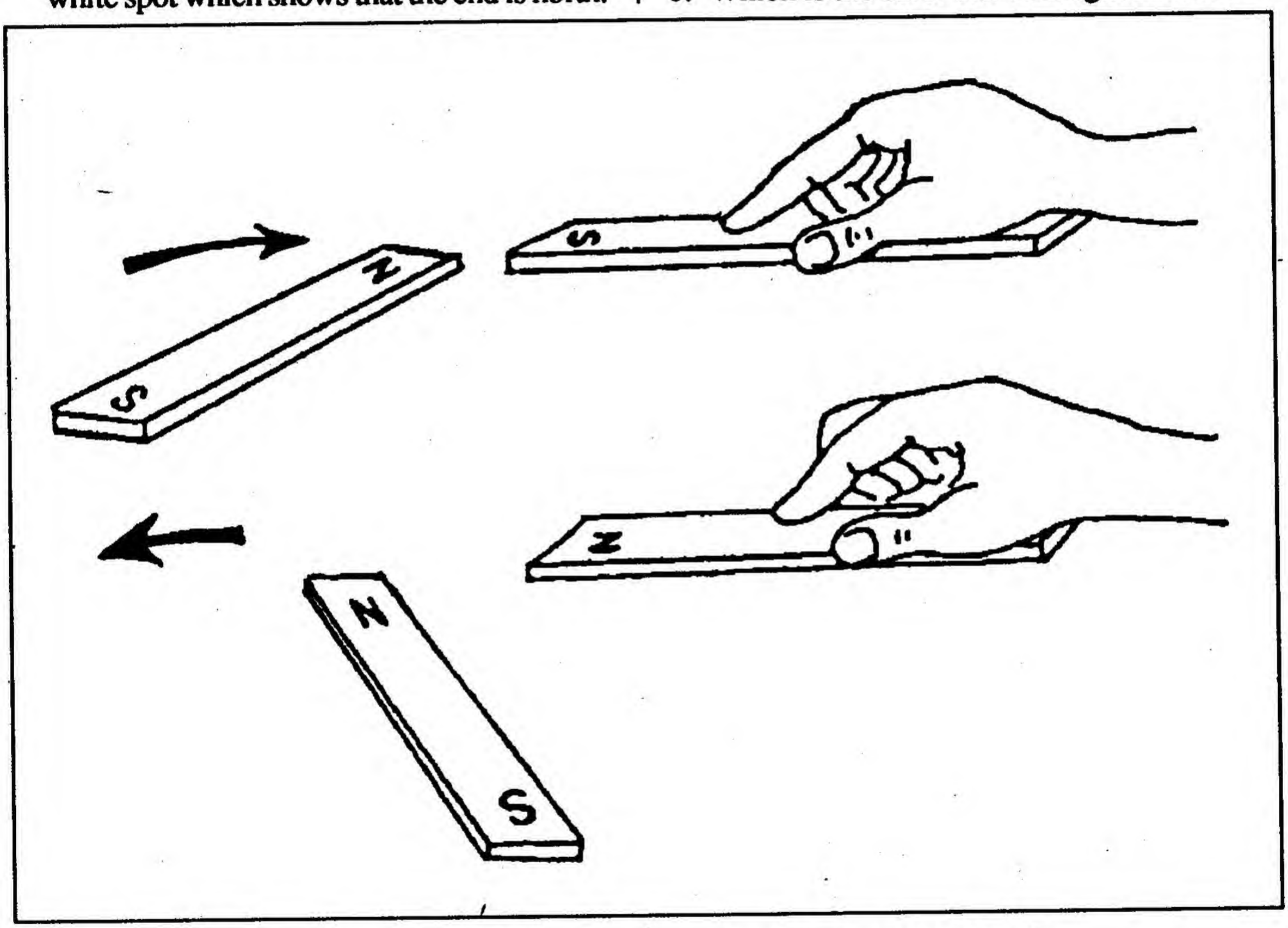
1. Two magnets

What to do ?

1. Normally, a bar magnet has in one end a white spot which shows that the end is north. Then the other end will be south.
2. Now bring the north end of one magnet near the north end of the other magnet. It will be seen that the magnets are repelled.
3. Similarly repulsion occurs if south ends are brought together.
4. Bring the north end of one magnet near the south end of the other. Both magnets will be attracted to each other.

Students to enquire

1. Which is the surer test of magnetization — attraction or repulsion ?



Explanation

1. The surer test of magnetism is repulsion, not attraction. A magnet will attract a magnetic substance at both ends. A magnetic substance cannot be repelled by a magnet.

75 A temporary magnet

Magnetism

Materials

1. A strong bar magnet
2. A long iron nail
3. Small nails

What to do ?

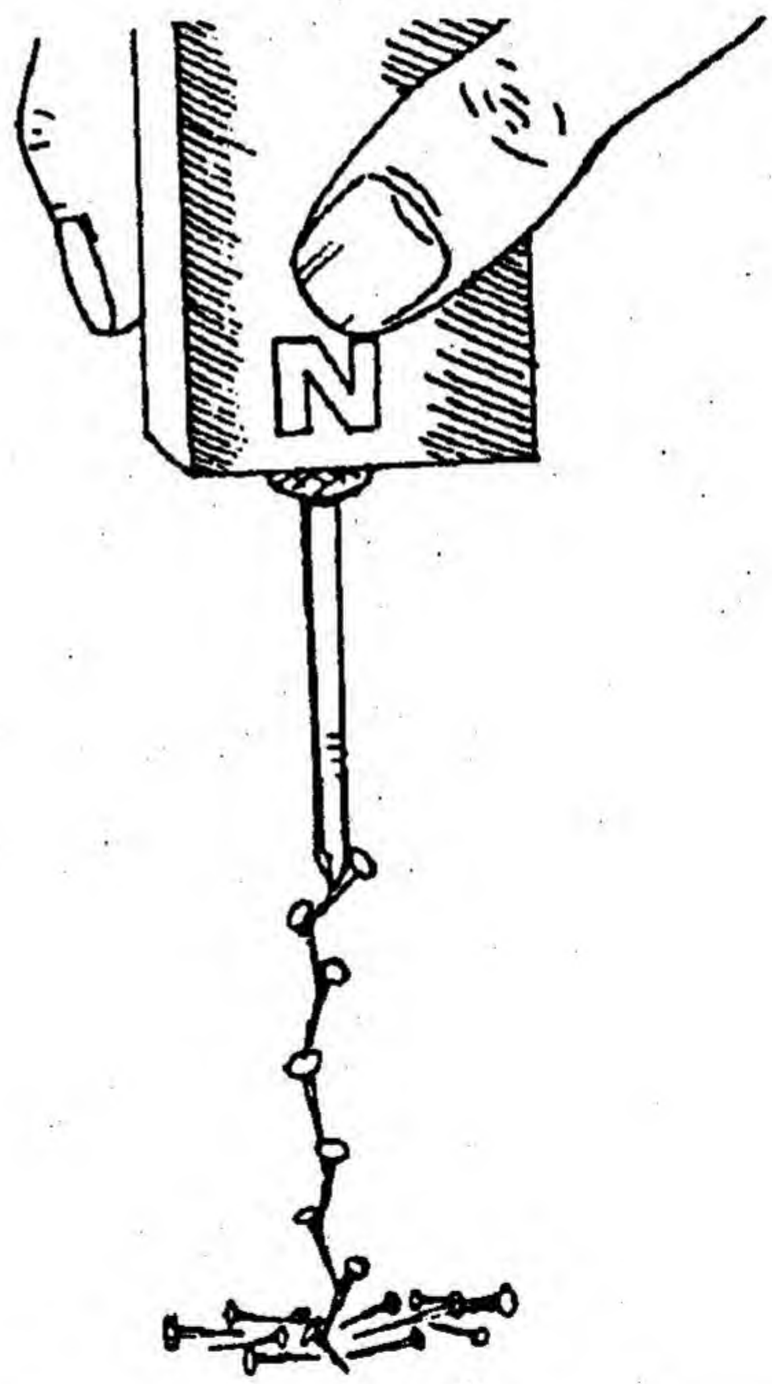
1. Place small nails in a heap on a table.
2. Touch a bar magnet on the long iron nail and then bring the pointed end of the nail near the heap of small nails.
3. The small nails will cling to the long nail in a chain.
4. Remove the magnet from the long nail. The small nails will immediately fall.

Students to enquire

1. Why does the long nail attract the smaller nail when the magnet touches the long nail ?
2. Will a copper nail or wooden nail attract small nails ?
3. What is the process of temporary magnetization called ?

Explanation

1. When the magnet touches the long iron nail, it becomes a magnet. Hence it attracts the small nails or any other magnetic material. The long nail will attract the small nails as long as the bar magnet touches the long nail. The nail becomes a temporary magnet.
2. A copper or wooden nail will not become a magnet when a magnet touches it. Hence it will not attract the small nails.
3. The process of temporary magnetization is called induction. The induced magnetism is temporary. The tiny molecular magnets in the iron nail align themselves systematically as long as the magnet touches the nail, but the molecular magnets become haphazard when the magnet is removed.



Magnetism

Magnetic force

76

Materials

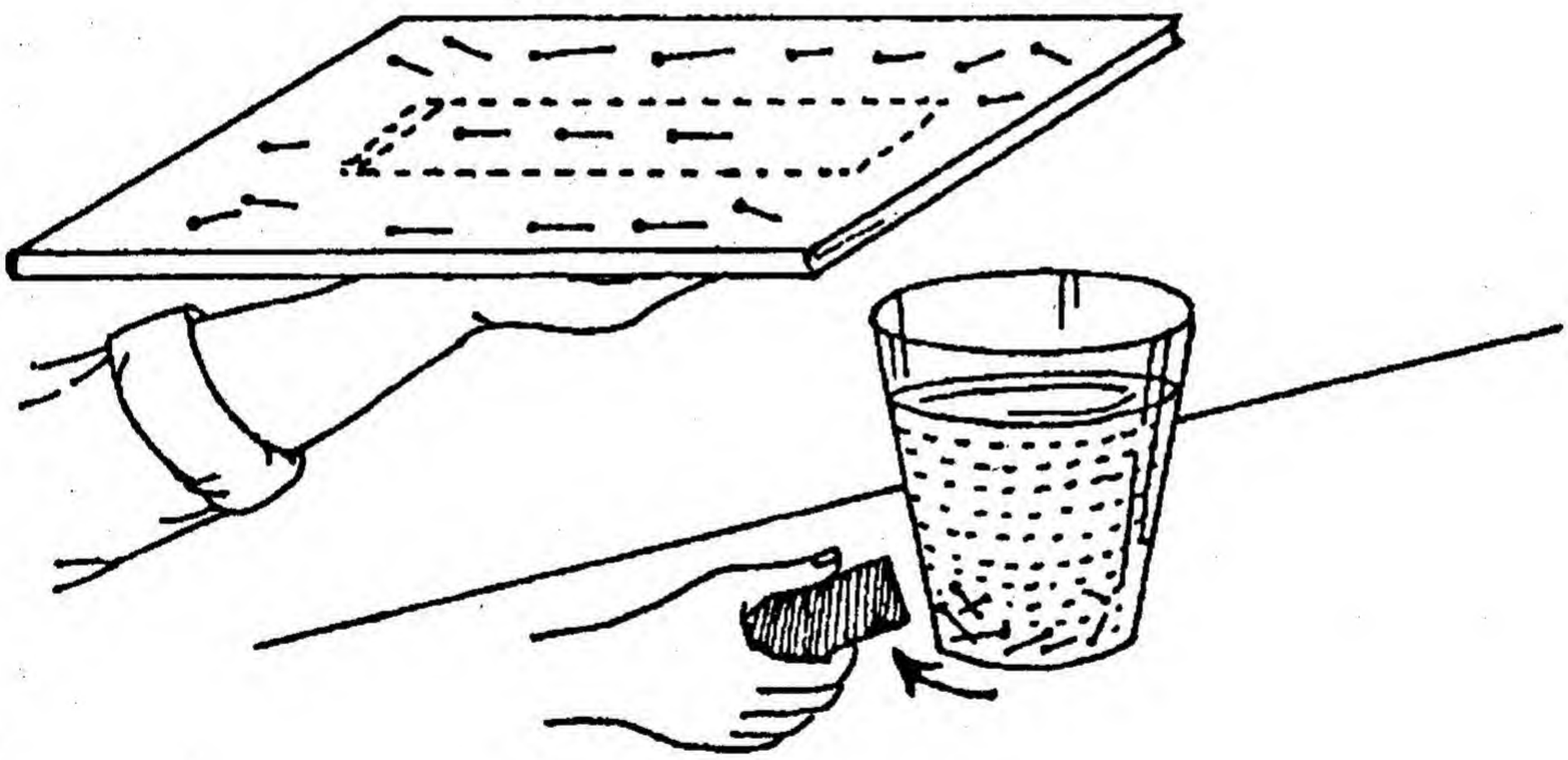
1. Small iron nails 5-10 pieces
2. A bar magnet
3. An exercise book
4. A glass of water

What to do ?

1. Place the nails over the exercise book.
2. Place the bar magnet below the exercise book, observe that the magnet affects the iron nails when the magnet is moved below the exercise book.
3. Take $^3/_4$th glass of water and drop a few iron nails in the water. Now take the bar magnet and hold it outside near the bottom of the glass and rotate it round the glass. What happens ?

Students to enquire

1. Does the magnet affect the iron nails through the exercise book ?
2. Does the magnet affect the iron nails through the water ?



Explanation

1. Yes, the iron nails are affected by the magnet through the exercise book.
2. Yes, the magnet affects the iron nails through the water.

77 Which one is a magnet

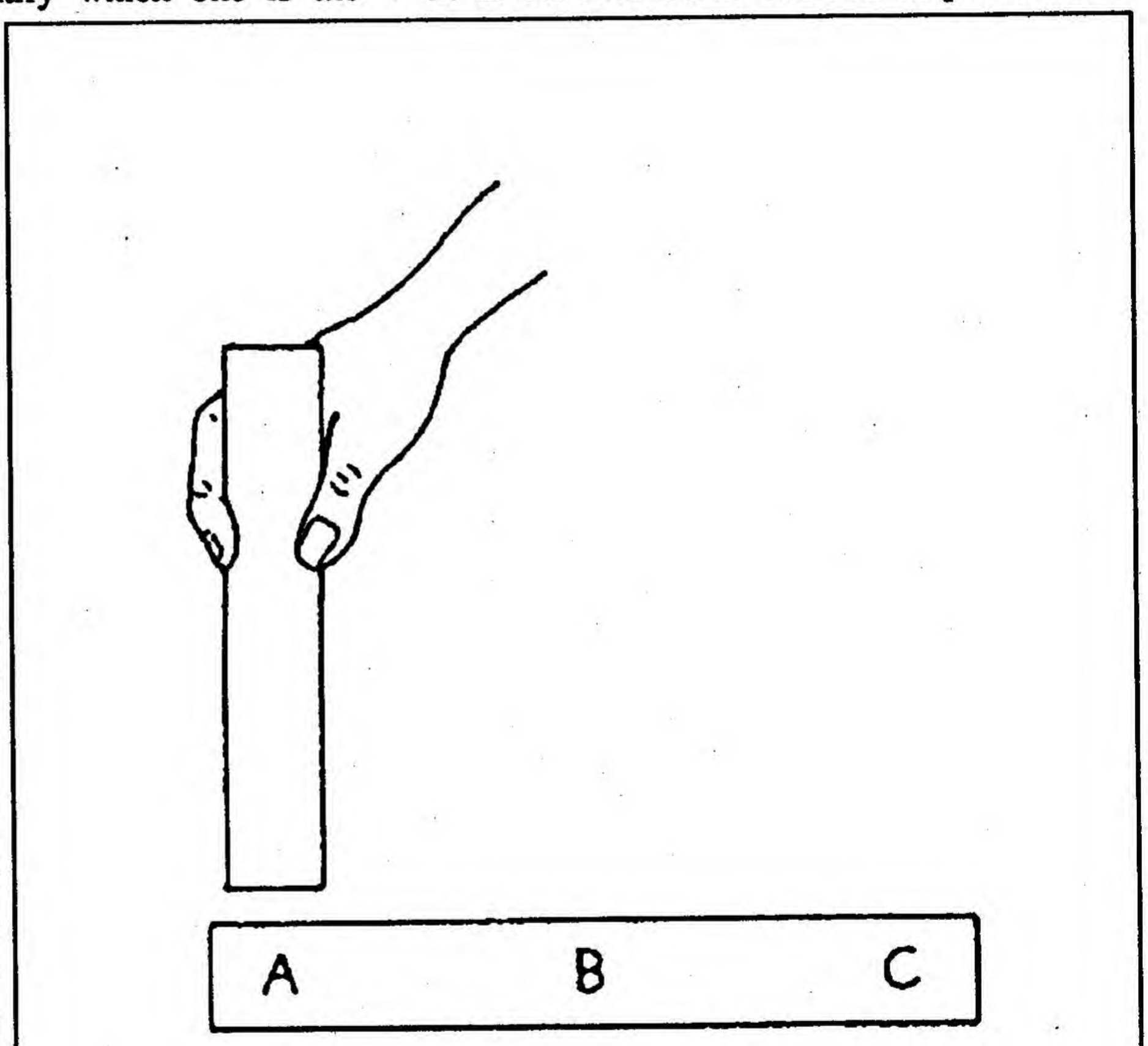
Magnetism

Materials

1. A bar magnet
2. An iron bar resembling a bar magnet

What to do ?

1. You have to identify which one is the magnet and which one is an iron bar.
2. Touch the end of one bar at points A; B, C of the other bar.
3. Observe what happens.
4. Now change the bars and do the same operation and observe the nature of attraction at the ends and in the middle.



Students to enquire

1. Why will one bar attract the other bar at all points ? What does that prove ?
2. When you reverse the bars you will observe there is no attraction in the middle, why ?

Explanation

1. If the bar magnet is touched at points A, B and C of the other bar, then it will attract the other bar at all points .It proves that the first one is a magnet and the other one is an iron bar.
2. If the iron bar is touched at points A, B and C of the magnet, then there will be attraction at A and C, but no attraction at B. The centre of a magnet is a neutral point.

Magnetism

Make a magnet

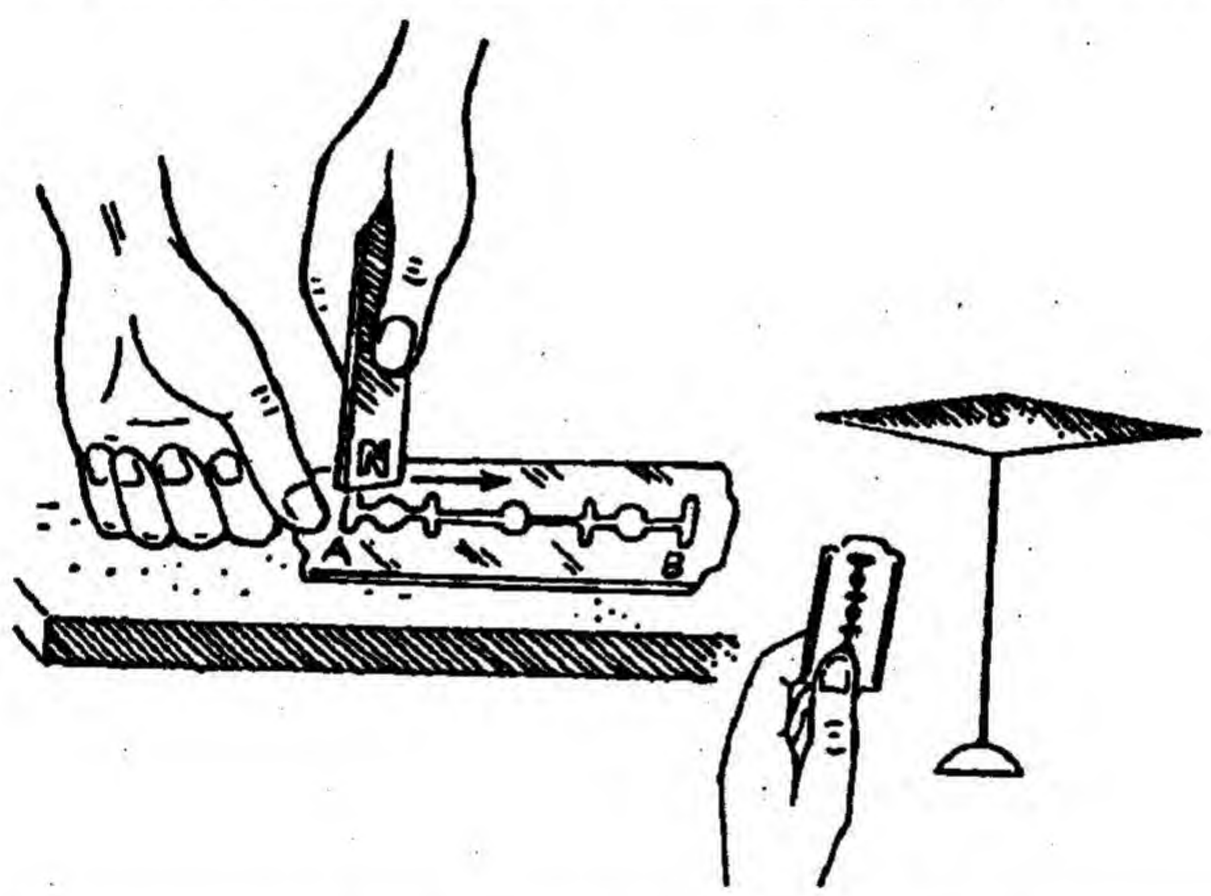
78

Materials

1. A used safety razor blade
2. A strong bar magnet
3. A magnetic needle

What to do ?

1. Place the blade on the table and hold it with a finger.
2. Hold the bar magnet vertically and press it on the blade at one end.



3. Then draw the magnet from end A to end B and then raise the magnet and draw it again from A to B.
4. Do it four or five times. The blade will become a magnet.
5. Bring one end of the blade near the north end of a magnetic needle. Observe what happpens.
6. Now bring the other end of the blade near the north end of the magnetic needle. Observe what happens.

Students to enquire

1. Why does the blade become a magnet ?
2. If you rub the north end of the magnet, what will be the polarity at A and B ?
3. If the end of a blade after magnetisation repels the north end of a magnetic needle, what polarity is formed at that part of the blade ?
4. What polarity is formed in the other end ?

Explanation

1. When the blade is rubbed with the magnet each tiny molecular magnet in the blade gets aligned systematically and becomes a magnet.
2. The end A becomes the north and the end B becomes the south.
3. If an end of a blade after magnetization repels the north end of a magnetic needle, then that end is the north pole.
4. The other end of the blade is the south pole.

79 Molecular magnetism

Magnetism

Materials

1. A test tube
2. Iron filings
3. A bar magnet
4. A magnetic needle

What to do

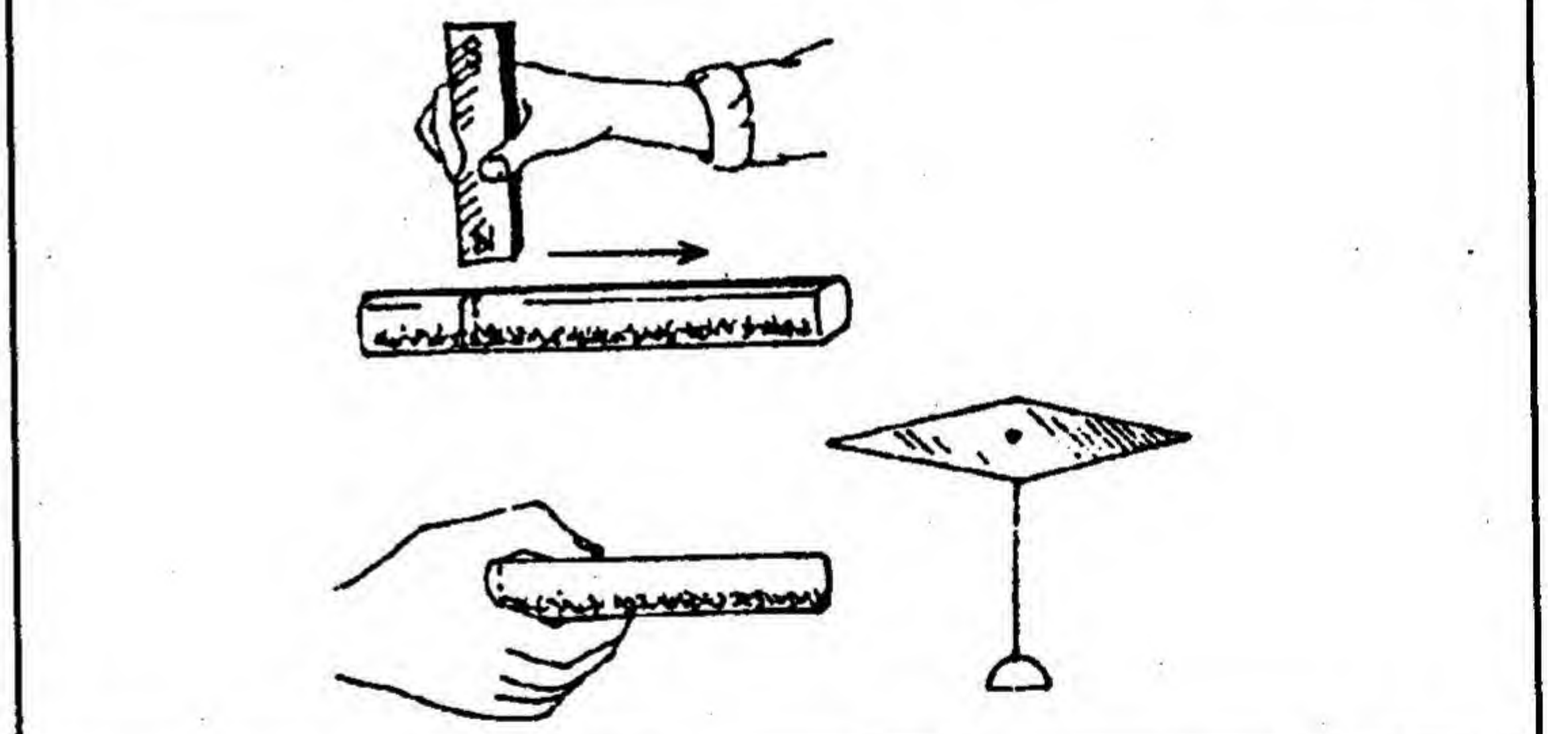
1. Fill the test tube three-fourths with iron filings. Close the mouth of the test tube with paper.
2. Spread the iron filings evenly in the test tube and keep it horizontal.
3. Take one end of the test tube at right angle to the needle towards the north and the south end of the needle and observe what happens. Repeat the same activity with the south pole.
4. Press the north pole of the magnet over one end of the test tube and take the magnet along the test tube to the other end. Repeat the operation three or four times.
5. Now, take the end of the test tube, from where the rubbing was started, towards the north pole of the magnetic needle. You will observe that the needle will be repelled.
6. Now, bring the other end of the test tube towards the north pole. You will observe that the needle will be attracted. It proves that the test tube behaves like a bar magnet.
7. Now, shake the test tube and repeat the operation. You will observe that the needle would not be deflected .This proves that the test tube does not behave like a bar magnet.

Students to enquire

1. Before magnetization why did both the ends of the test tube get attracted by the magnetic needle ?
2. How was the test tube converted into a magnet ?
3. How does this experiment explain the molecular theory of magnetism ?

Explanation

1. A magnetic needle is a very weak magnet. The test tube has iron filings. Hence both the ends are attracted by the magnetic needle.
2. When the test tube is rubbed with a magnet, then the iron filings get magnetised and arrange themselves. For this the test tube behaves like a bar magnet.
3. All the molecules in a magnetic substance are small magnets. Normally, the molecular magnets are arranged in domains in such a way that the substance does not show any magnetic property. But when the magnetic substance is magnetized, the molecular magnets align themselves in such a way that the substance shows magnetic property.



Magnetism

Magnetic screening

80

Materials

1. A bar magnet
2. A plastic sheet
3. A thin iron sheet
4. A few small nails

What to do ?

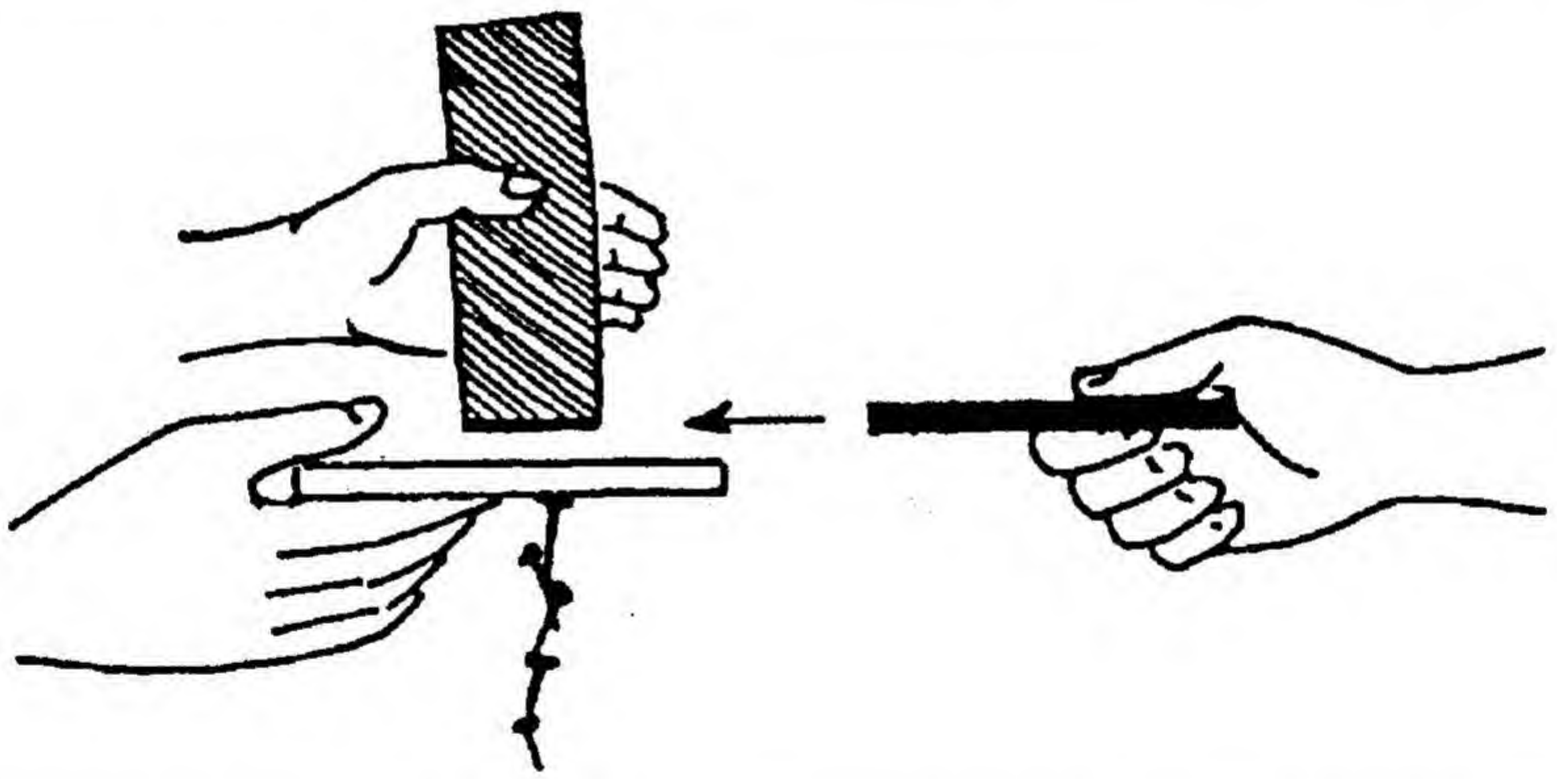
1. Hold the magnet vertically and place the plastic sheet below the magnet. Now, bring the magnet with the plastic sheet near the nails. You will observe that the nails are attracted by the magnet and they stick to the sheet though there is no direct connection between the magnet and the nails.
2. Now, raise the magnet a little and introduce the iron sheet over the plastic sheet. You will observe that the nails fall off the sheet.

Students to enquire

1. Why do the nails stick to the plastic sheet even though the nails do not touch the magnet ?
2. Why do the nails fall off when the iron sheet is introduced ?
3. Will the nails fall off if a copper or aluminium sheet were introduced instead of the iron sheet ?

Explanation

1. The magnetic lines of force pass through the plastic sheet. Hence the nails are attracted owing to magnetic induction.
2. When an iron sheet is introduced the magnetic lines of force get concentrated in the iron sheet and do not pass through the iron sheet. Hence the magnet cannot induce magnetism in the nails. So the nails fall off. This is called magnetic screening.
3. If a copper or aluminium sheet were introduced, then the nails would not fall off. This is due to the fact that aluminium and copper are not magnetic substances. Non-magnetic substances cannot screen the lines of force.



81 Rainbow on paper

Light

Materials

1. Water in a container
2. A mirror
3. A white sheet of paper

What to do ?

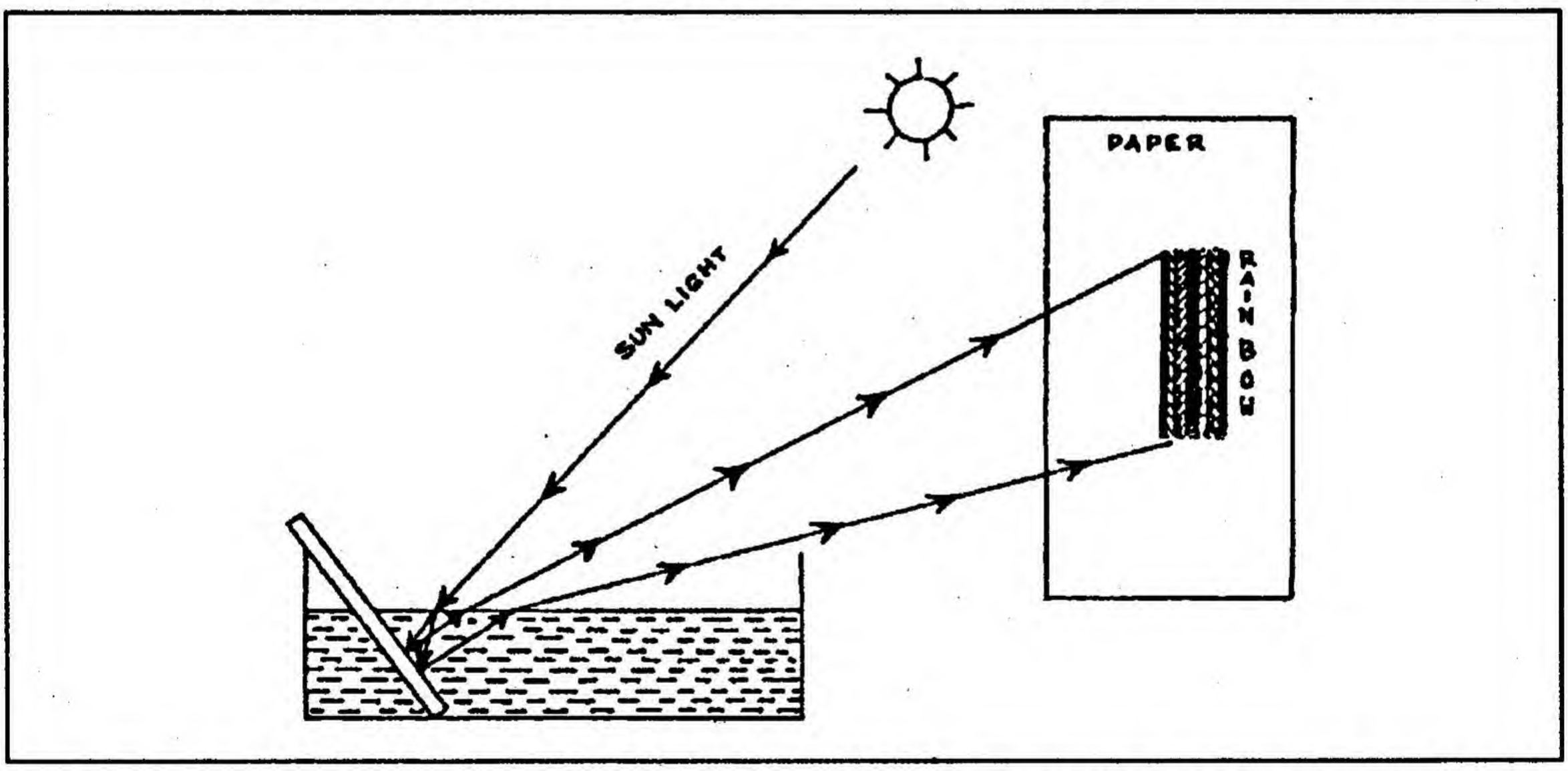
1. Place the mirror in the container in such a way that the major part of the mirror is below the water.
2. Do the experiment in sunlight. Try to reflect the sunlight on the paper with the mirror. You have to keep the paper fixed and the reflection of sunlight should take place from that part of the mirror which is below the water. You have to adjust the mirror, if necessary.

Students to enquire

1. What happens if the sunlight falls on that portion of the mirror which is above the surface of water ?
2. When the sunlight falls on the water, what happens to the light ?
3. How is the rainbow created on the paper ?

Explanation

1. If the sunlight falls directly on the mirror, the light gets reflected.
2. When the light falls on the surface of the water, it gets refracted.
3. Sunlight is composed of seven colours. When the sunlight falls on the surface of the water, the seven colours are refracted at different angles and are separated. When these colours fall on the submerged portion of the mirror, they get reflected. When these different coloured lights come out of the water, they form the rainbow on the paper.



Light

Disappearing coin

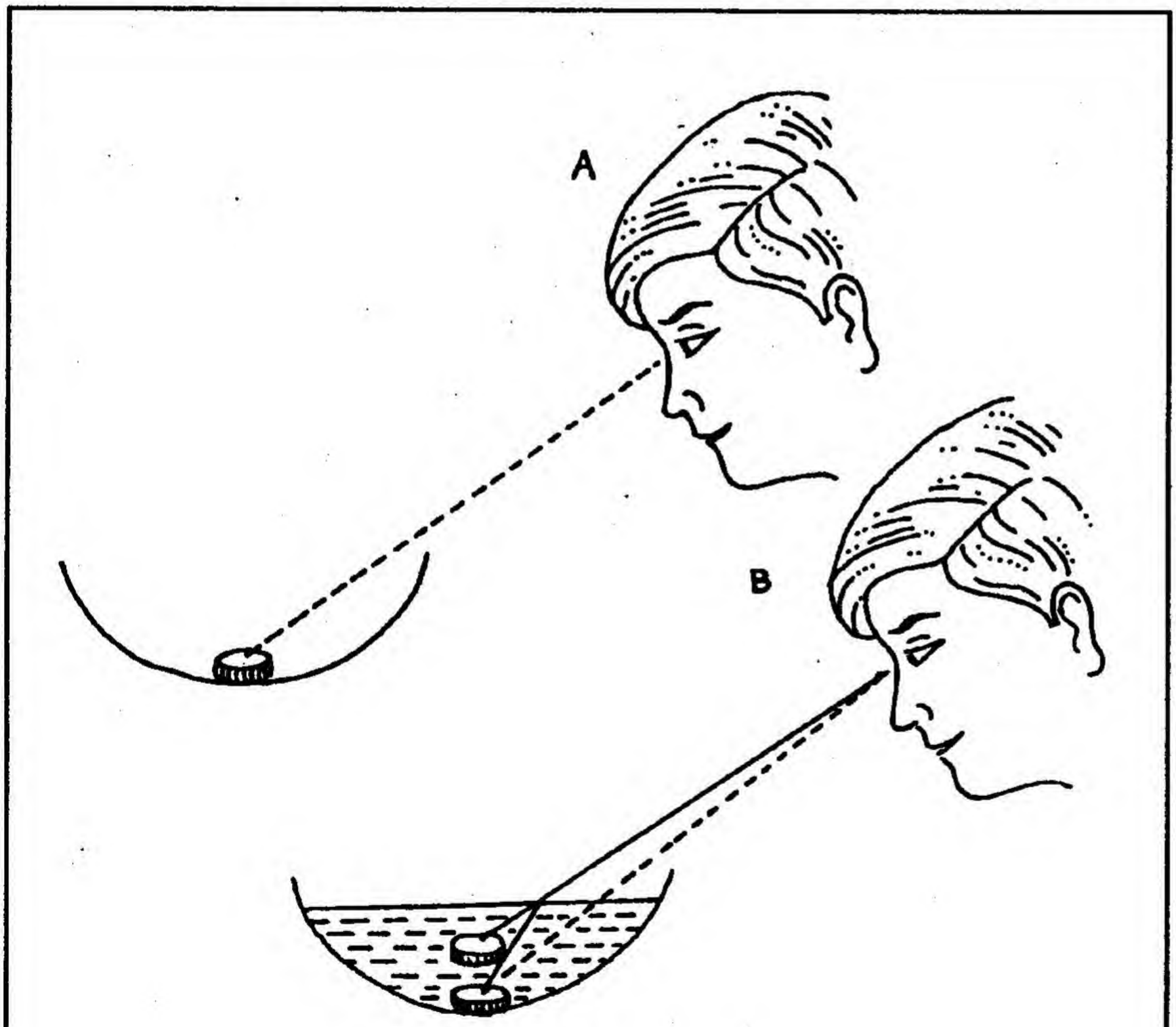
82

Materials

1. A bowl
2. A coin
3. Water

What to do ?

1. Place a coin at the centre of the bowl.
2. Place your eyes in such a positon that the coin just vanishes from your sight. Keep your eyes fixed there (Fig. A).
3. Now let your friend gently pour water into the bowl without displacing the coin.
4. You will observe that the coin suddenly comes into your sight though you have not movcd your eyes (Fig. B).



Students to enquire

1. Why could you not see the coin when you placed your eyes as at point A?
2. Why does the coin reappear again?

Explanation

1. We see an object when light from that object comes to our eyes. Because the rim of the bowl obstructed the light from reaching our eyes we could not see the coin.
2. When light rays pass from one medium to another, they bend from their original path. This bending of light is called refraction. When light passes from a denser to a rarer medium it bends away from the normal to the water surface. Due to this an object in water is seen raised. This refraction of light from the water surface made the coin visible.

83 Increasing the sound

Sound

Material

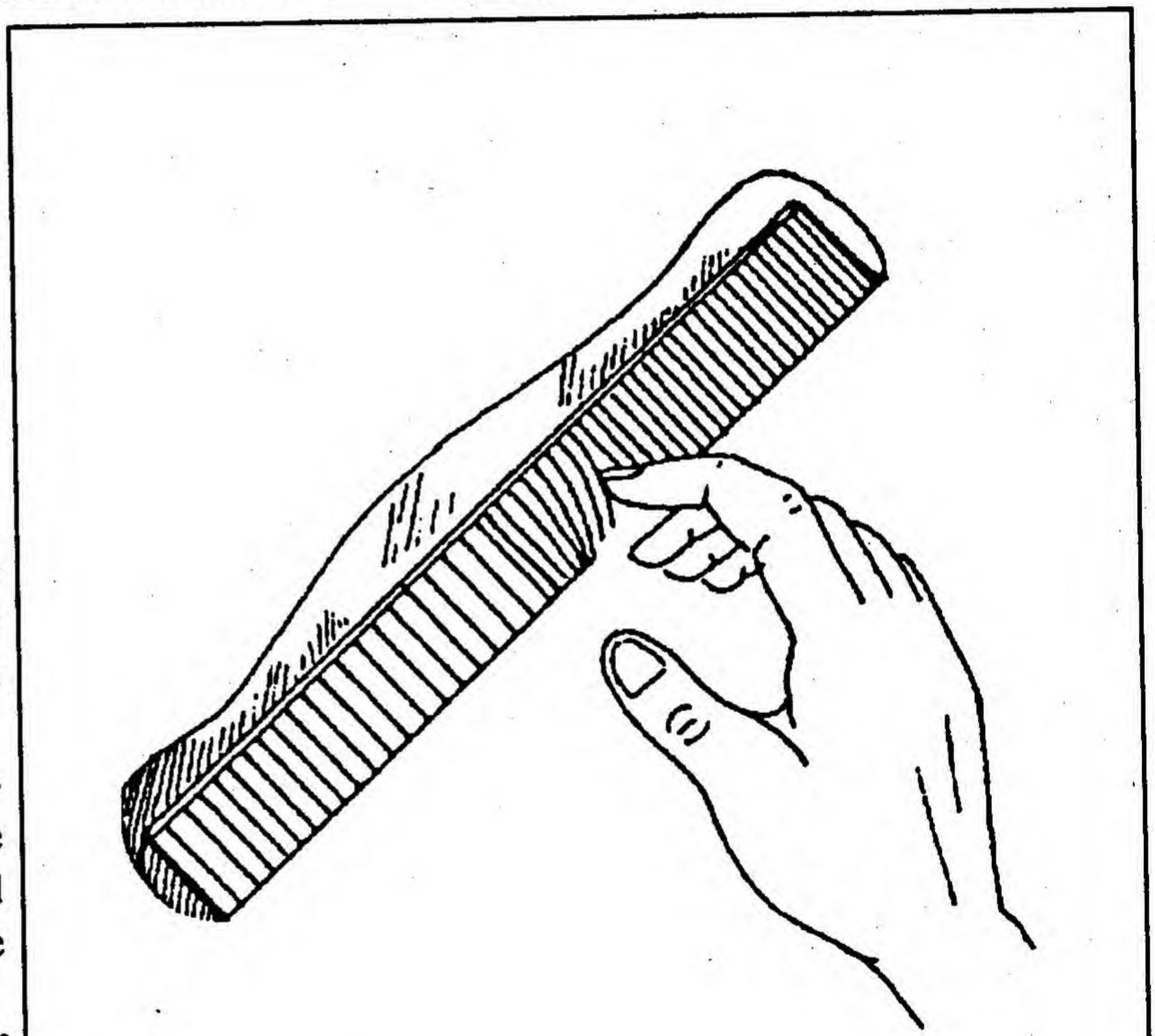
1. A comb.

What to do ?

1. Hold the comb with your left hand. Draw your finger over the teeth of the comb from one end to the other. Listen to the sound.
2. Now, keep the comb vertically on the table. Repeat the operation. You will observe that the intensity of sound has increased .
3. Keep the comb on other objects and repeat the experiment.

Students to enquire

1. Why does the comb make a sound when you draw your finger over the comb ?
2. Why does the sound increase when you keep the comb on the table and draw your finger over the comb ?
3. Where is this method of increasing the sound utilised ?



Explanation

1. When you draw your finger over the comb, the teeth start vibrating. A vibrating body gives out sound.
2. When you draw your finger over the comb held in the air, only the teeth and the comb start vibrating. But when the comb is held on the table a forced vibration is set on the table also. Owing to the combination of these two vibrations of the comb and the table the intensity of sound is increased.
3. In different instruments like the sitar, the sarod, the violin, the tanpura there is a hollow box made of wood or other material. This increases the sound when the instrument is played.

Sound

Sound in a bottle

84

Materials

1. A narrow-necked empty bottle
2. Water
3. A scale or a key

What to do ?

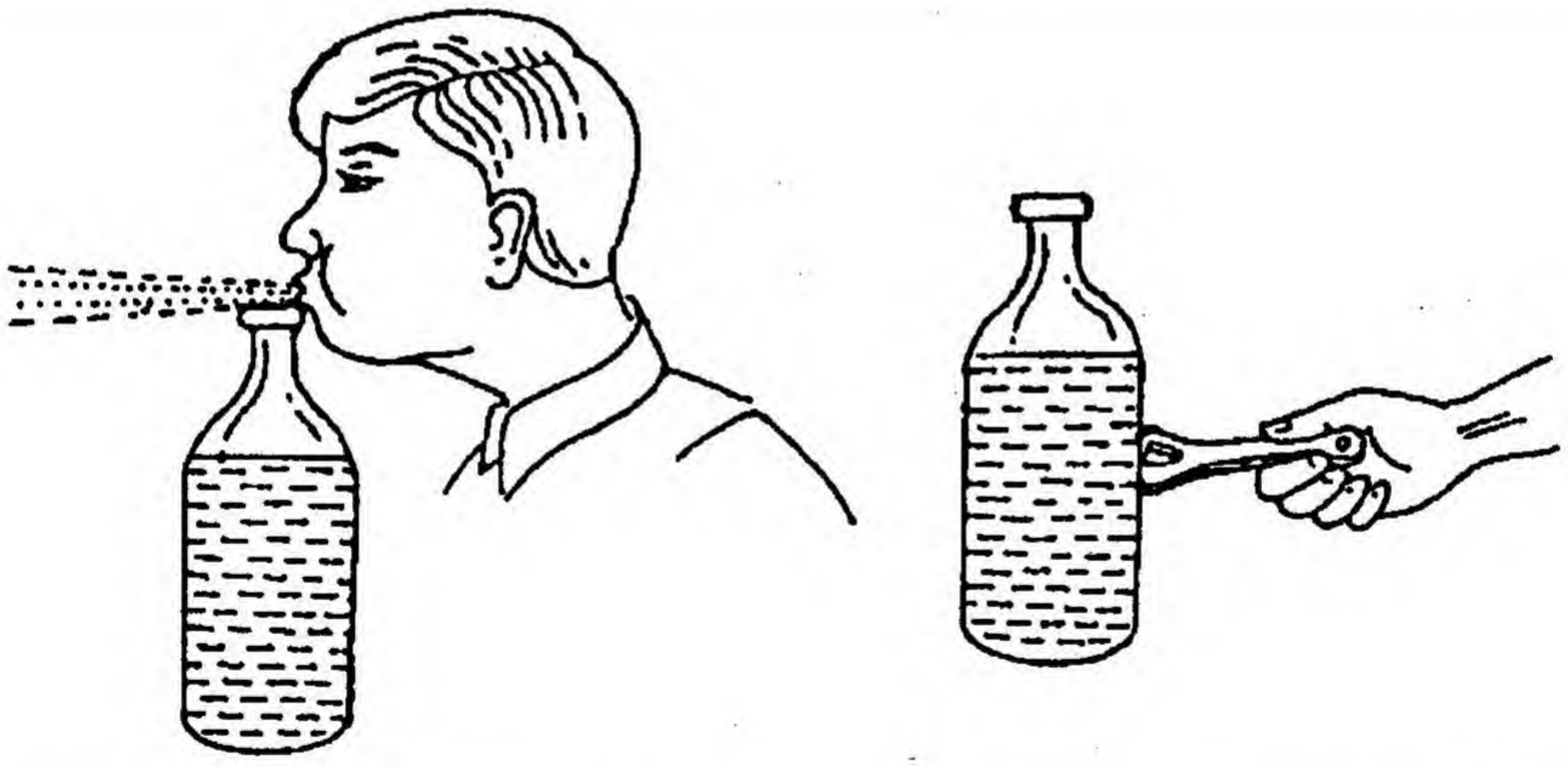
1. Fill the bottle with water keeping a little gap at the top. Blow air at the mouth and try to bring out sound like a flute. Notice the pitch of the sound.
2. Reduce the water of the bottle in steps and repeat the activity. Notice the pitch of the sound as the water level goes down.
3. Now, fill the bottle again with water and strike the bottle with the key or the scale. Notice the pitch.
4. Reduce the quantity of water in steps and repeat the activity. Notice the pitch of sound as the water level goes down.

Students to enquire

1. What happens to the pitch of the whistling bottle as the water level goes down ?
2. Why does it change so ?
3. What happens to the pitch of the struck bottle as the water level goes down ?
4. Why does it change so ?

Explanation

1. As the water level goes down the pitch of the whistle sound also goes down.
2. The length of the vibrating air column increases as the water level goes down. The pitch of vibrating air column is inversely proportional to its length. Hence, the more the length the less is the pitch.
3. If you strike the bottle as the water level goes down, the pitch of sound goes on increasing.
4. As you reduce the water , the total mass of the bottle lessens. The pitch of sound increases with the reduction of the mass of the bottle.



85 Dancing paper strips

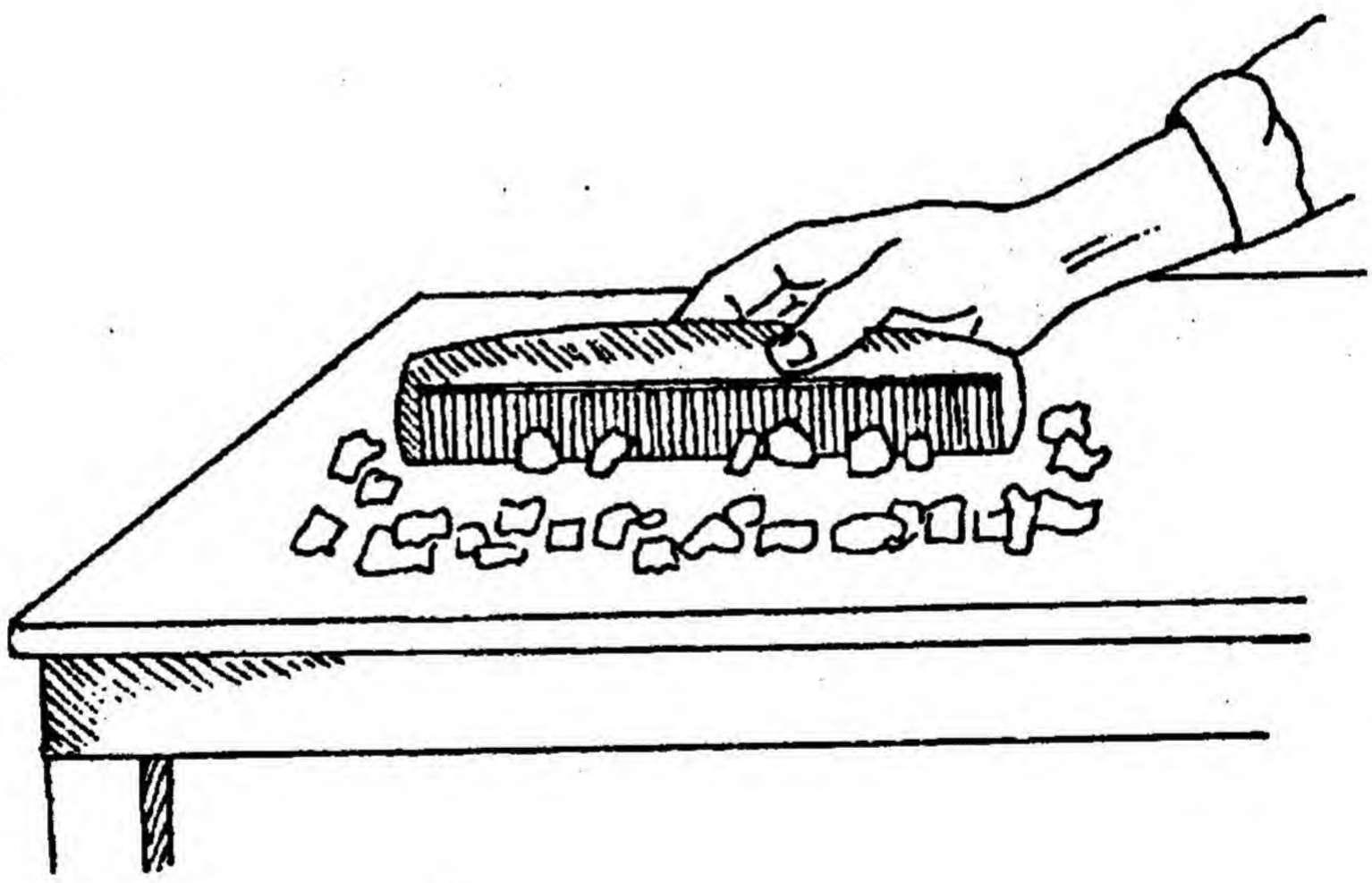
Static Electricity

Materials

1. A plastic comb
2. Some small pieces of paper

What to do ?

1. Take the dry comb and comb your dry hair two or three times.
2. Then, bring the comb near the pieces of paper .You will observe that the pieces are attracted by the comb.



3. Wet the comb with a little water and see if the pieces of paper are attracted.

Students to enquire

1. Why are the pieces of paper attracted by the comb ?
2. If the comb is negatively charged, what is the charge formed in the pieces of paper or aluminium foil ?
3. What other materials can be charged ?

Explanation

1. When the hair is combed, the comb is charged (electrically negative). When the charged comb is brought near paper, aluminium foil or thread, the opposite charge is induced in them. Opposite charges attract each other. Hence the comb attracted the pieces of paper, thread or aluminium foil.
2. If the comb is negatively charged the pieces of paper or aluminium foil or thread will be positively charged.
3. If we rub plastic, glass or ebonite rods with wool, flannel or silk they will be charged.

Static Electricity

Bending of water stream

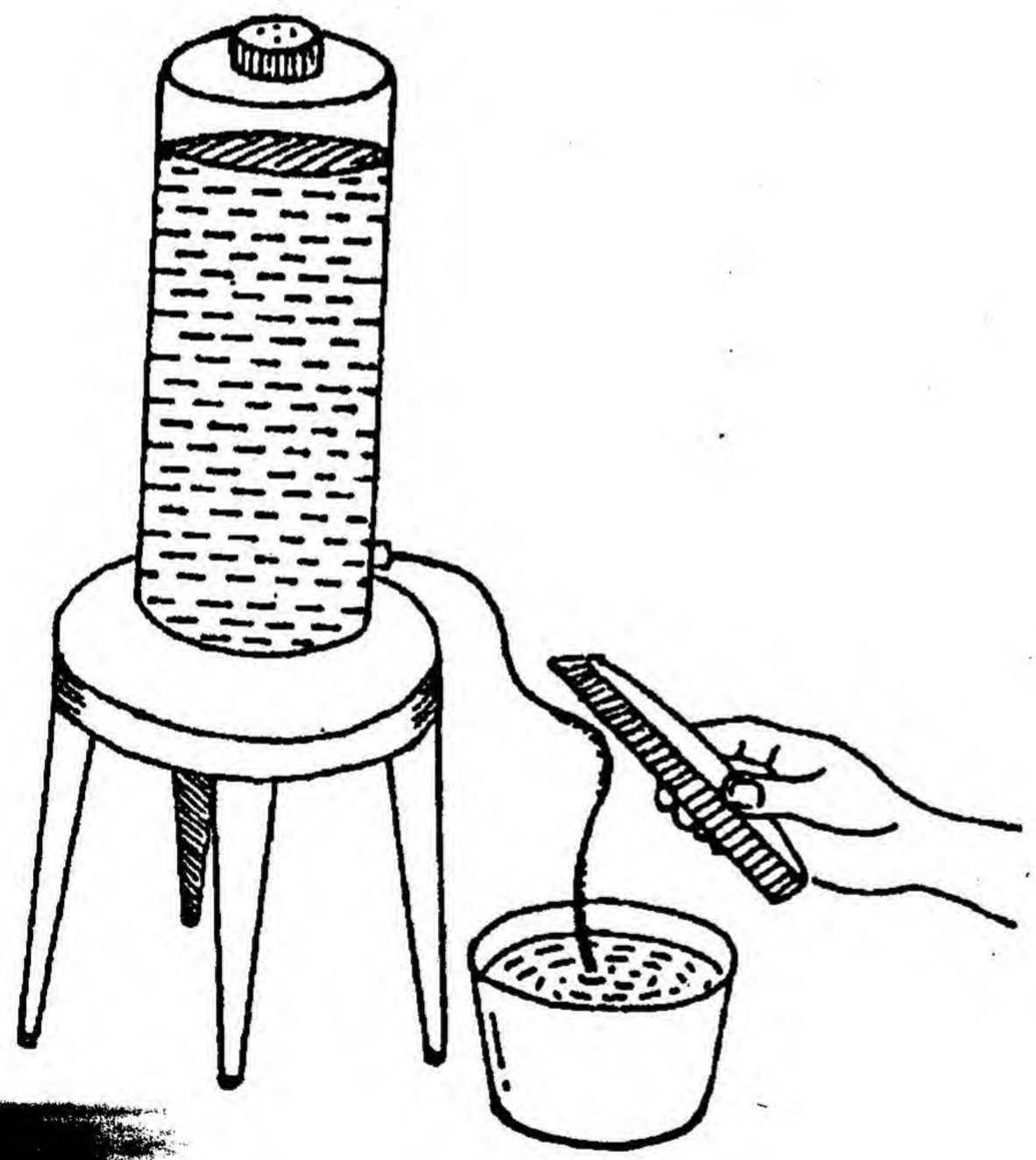
86

Materials

1. A plastic comb
2. An empty powder can with a hole at the bottom
3. A bucket

What to do ?

1. Fill the can with water and let the water fall into the bucket.



2. Rub the comb on your hair and hold the comb near the flowing water.
3. You will observe that the water stream will be attracted towards the comb.
4. If the comb or the hair is wet, the experiment will not work.

Students to enquire

1. Why does the water stream bend towards the comb ?
2. Will a thick stream of water bend ? If not, why ?
3. Why does not the stream bend if the comb is wet ?
4. What else can you use besides a comb ?

Explanation

1. When the hair is combed the comb becomes charged. When the charged comb is brought near the water stream, the stream gets an opposite charge by induction. This is why the stream gets attracted by the comb.
2. As the attractive force of static electricity is very feeble it cannot bend a thick stream.
3. If the comb or the hair is wet, the comb will not be charged. This is the reason why in the rainy season the static electricity experiments are difficult to be performed.
4. Besides a comb one can use a balloon, a piece of hard rubber, plastic cards or a glass rod. One has to rub these with silk,or wool, or flannel.

87 Separating pepper powder from sugar

Static Electricity

Materials

1. Sugar and pepper powder
2. A dry comb

What to do ?

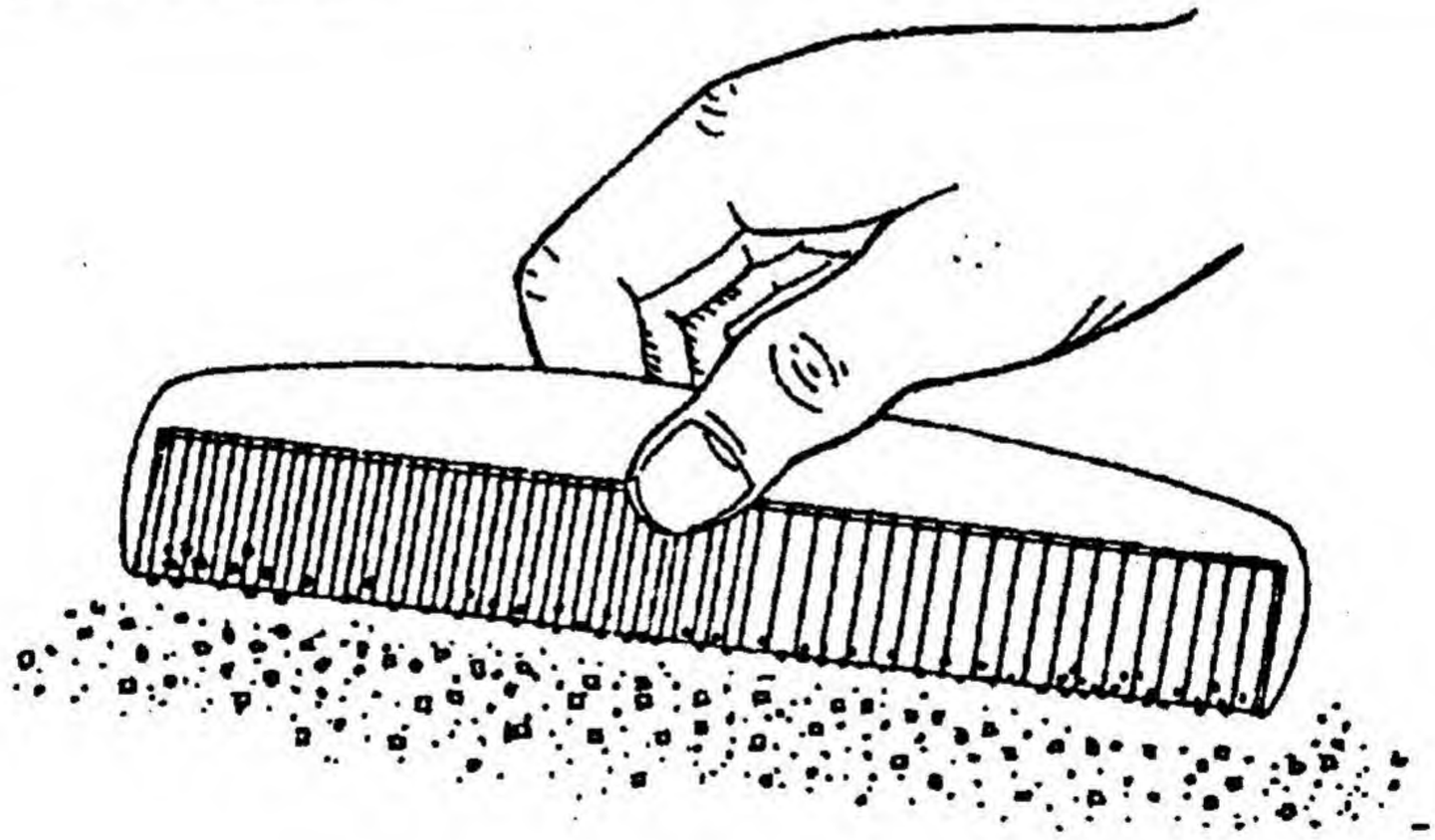
1. Mix sugar and pepper powder and spread it on a piece of paper.
2. Comb your hair and bring the comb near the mixture of sugar and pepper powder. You will observe that the pepper powder will be attracted very easily by the comb. Collect the powder on a piece of paper by striking the comb on the table.
3. You can seperate all the pepper powder by repeating the operation several times.
4. You will observe that if you do not comb your hair, the pepper granules will not be attracted by the comb.

Students to enquire

1. Why are the pepper granules attracted when you use the comb after using it on hair ?
2. Why are not the sugar crystals attracted ?
3. In what other ways can you separate the pepper powder from the sugar ?

Explanation

1. When you comb your hair, the comb is charged. When you bring the charged comb near the mixture, the opposite charge is induced in the pepper powder. Hence the granules of pepper are attracted by the comb.
2. The sugar is not attracted by the charged comb because of its chemical composition.
3. If we mix sugar and pepper powder in water, sugar will be dissolved in water, but pepper powder will not. It will float on water. You can easily strain the pepper powder and separate it from the sugar solution. If you now evaporate the water of the sugar solution, sugar crystals will be left. In this way also you can separate the two compounds of the sugar and pepper powder mixture.



Static Electricity

Hanging balloon

88

Materials

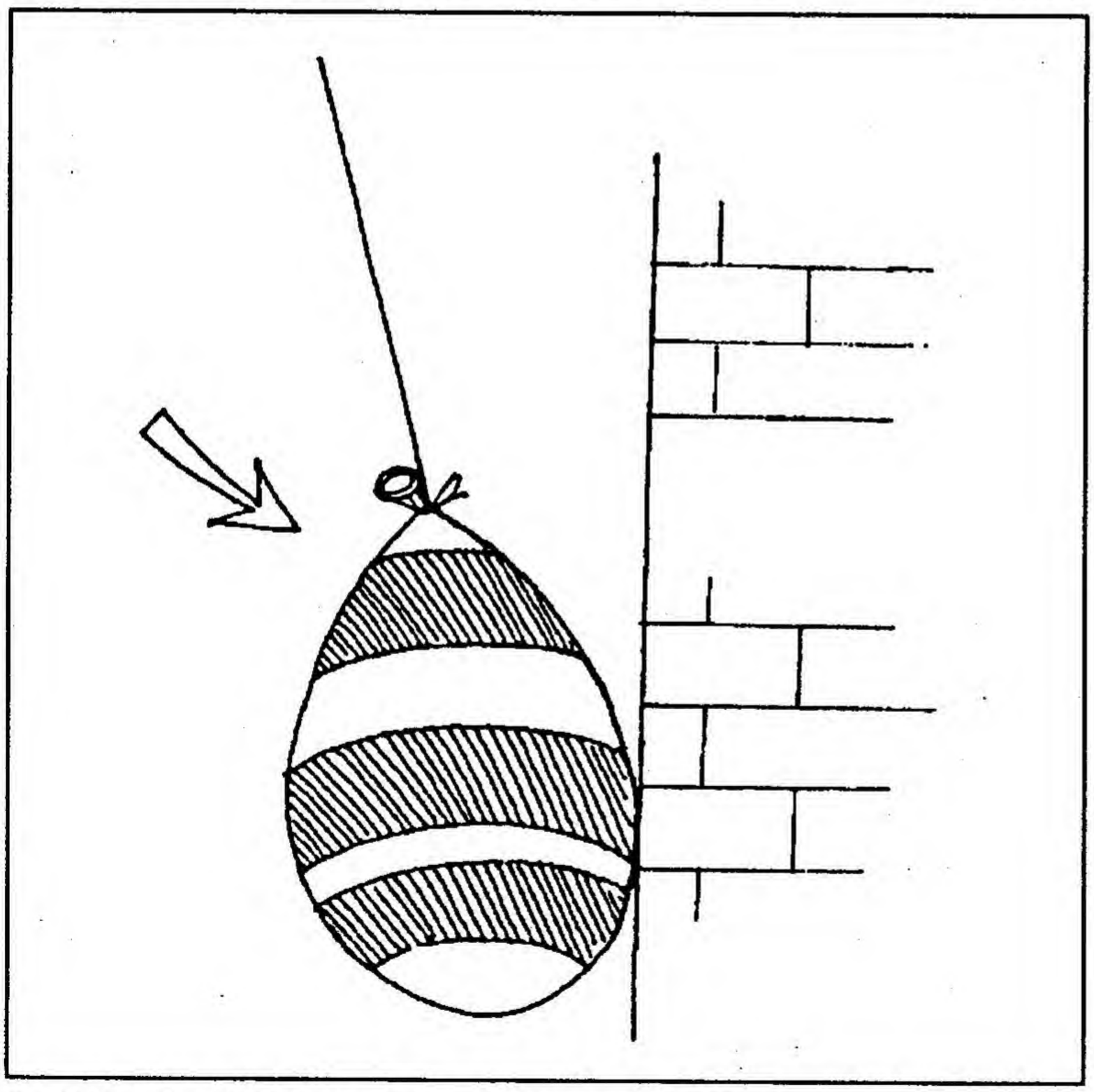
1. Three balloons

What to do ?

1. Rub the balloons on your shirt.
2. Take the balloons close to a dry wall. You will observe that the balloons get stuck to the wall.

Students to enquire

1. Why are the balloons rubbed on the shirt ?



2. Why do the balloons stick to the wall ?
3. Why is a dry wall required for the experiment ?
4. Will the balloons stick for ever to the wall?

Explanation

1. The balloons are rubbed on the shirt to get them charged.
2. When the balloons are rubbed, some electrons pass from the shirt to the balloon. Normally there are equal numbers of protons and electrons in an uncharged object. Hence the object is electrically neutral. But, when excess of elcctron accumulates on the balloon it gets negatively charged. When negatively charged balloons are brought near the wall, the electrons on the surface of the wall are repelled. Thereby the wall gets positively charged. Unlike charges attract each other. Hence the balloons get stuck to the wall.
3. If the wall is wet, it will lose charge very quickly. The same thing happens if the air is very humid. Hence the wall has to be dry.
4. If the balloons are kept on the wall for long, then the excess elcctrons from the balloons will flow back to the wall. The balloons will become neutral and will fall. Moreover, if the balloons are kept for long, they will gradually collapse.

89

Charged Scale

Static Electricity

Materials

1. A plastic or wooden scale
2. A dry comb

What to do ?

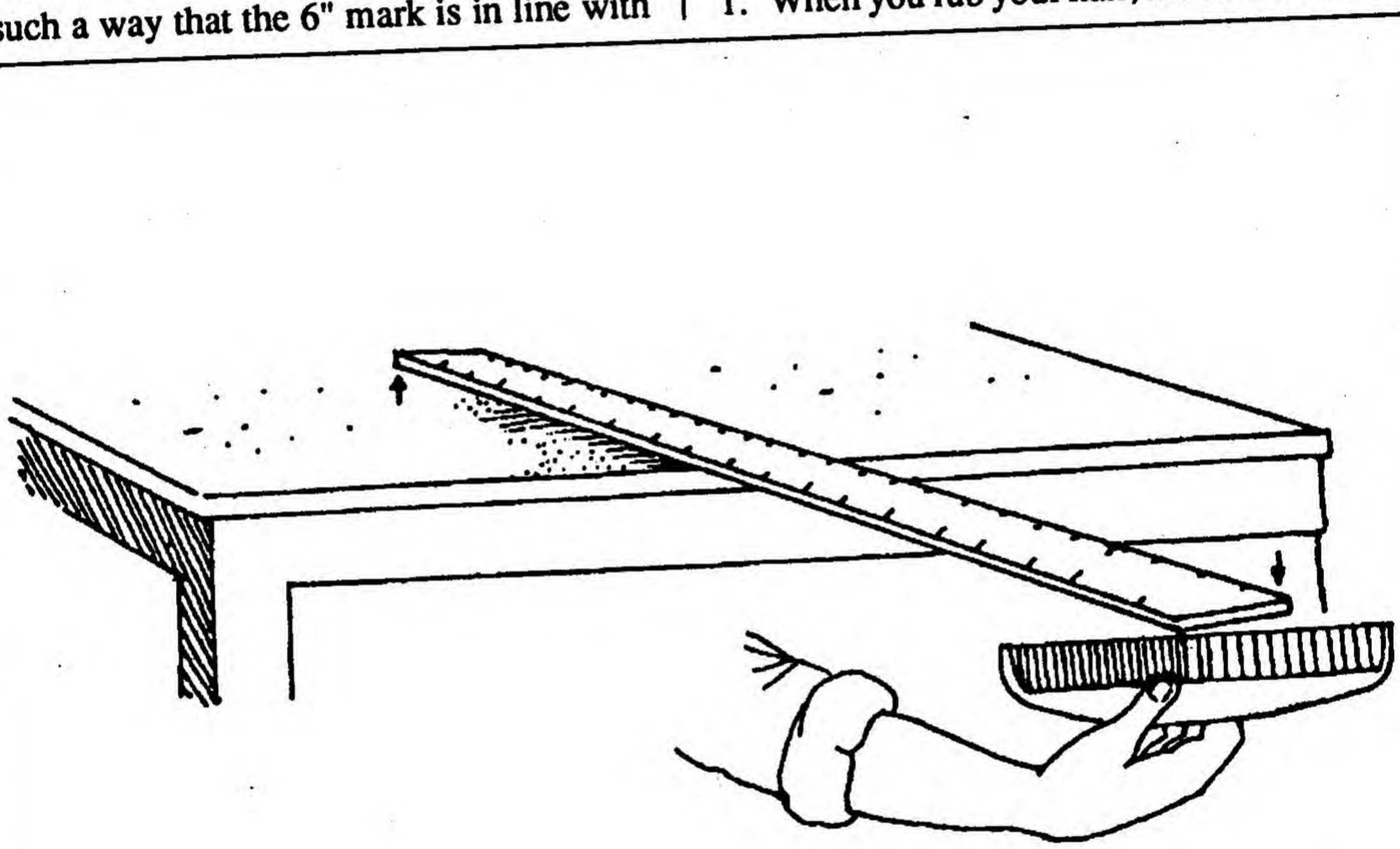
1. Place the scale at the edge of the table in such a way that the 6" mark is in line with the edge of the table and the scale just balances.
2. Brush your dry hair with the comb and bring the comb below that end of the scale which is outside the table. You will observe that the comb will attract the scale and it may tumble down.

Students to enquire

1. Why does the comb attract the scale ?

Explanation

1. When you rub your hair, the comb becomes charged. When the charged comb is brought near the scale, the opposite charge is induced in the scale and the scale is attracted by the comb.The scale loses its balance and is likely to tumble down.



Chemistry

Fire by water

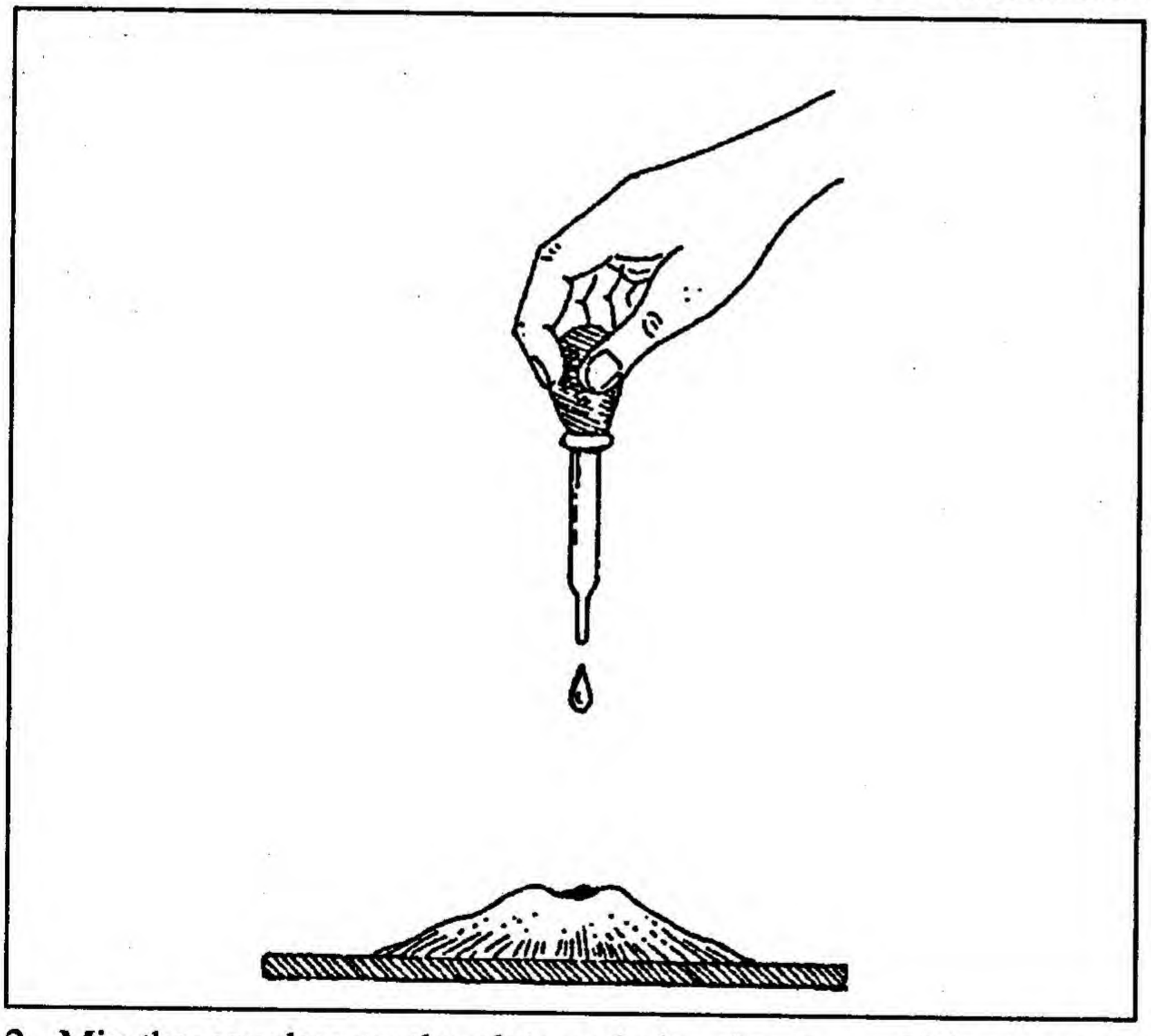
90

Material

1. A piece of asbestos or a metal plate
2. An ink dropper
3. Aluminium dust
4. Iodine crystals

What to do ?

1. Take one teaspoonful of iodine crystals and crush it. Take the same amount of dry aluminium powder.



2. Mix the powders on the plate and give the mixture the shape of a cone and make a depression on the top.
3. With the help of a dropper, let one or two drops of water fall on the top of the heap.
4. After a little while you will observe that smoke starts coming out and then the reagents catch fire.

Students to enquire

1. Why do you have to grind the iodine crystals ?
2. Why do the reagents have to be dry ?
3. Will the reagents react without water ?
4. Where in our daily life does water produce a reaction like this ?

Explanation

1. If you crush the iodine crystals, the contact area between the two reagents increases. This increases the rate of reaction.
2. If the reagents are wet, the heat created by the reaction will be absorbed by water and the rate of reaction will be lowered. For this reason the reagents will not catch fire.
3. Water acts as a catalyst. Reaction will not start without water. Water first helps in starting the reaction in a few molecules. This causes generation of heat which in turn helps in further reaction.
4. In our daily life, rust is formed because of similar reaction aided by water.

91 Ammonia fountain

Chemistry

Materials

1. A 500 c.c. round-bottomed flask
2. A two-holed rubber stopper with a long glass tube in one hole and an ink dropper in the other hole
3. A test tube with a rubber stopper through which there is a bent tube
4. A 500 c.c. beaker full of water
5. Ammonium chloride (NH_4Cl) and calcium carbonate ($CaCO_3$).
6. A spirit lamp or a gas burner or a heater

What to do ?

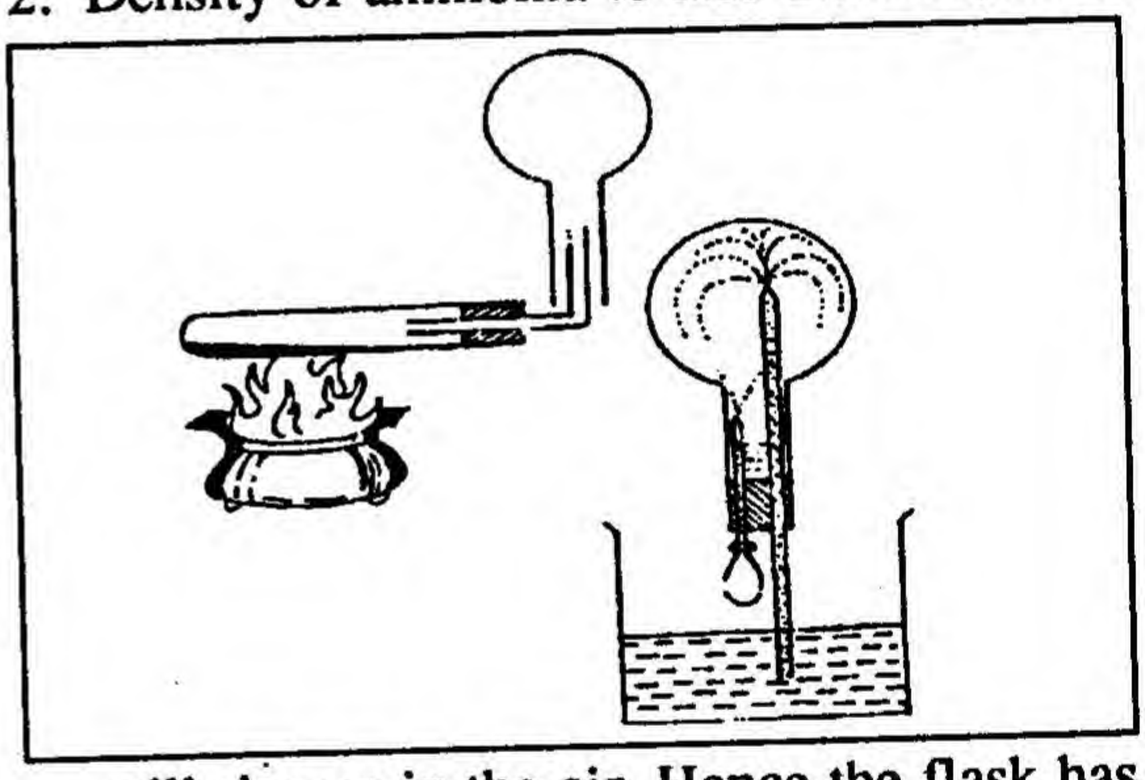
1. Take NH_4Cl and $CaCO_3$ in the test tube. Close the mouth of the test tube with the stopper and heat it.
2. Fill the ink dropper with water.
3. Invert the flask and introduce the bent tube inside the flask.
4. You will get the pungent smell of ammonia. Continue heating the flask for a few seconds more. Then close the mouth of the flask with the rubber stopper having the long tube and the ink dropper.
5. Keeping the flask inverted, immerse the end of the long tube in the beaker of water. Sprinkle a little water inside the flask by pressing the rubber of the ink dropper. You will observe that water will enter the flask like a fountain.

Students to enquire

1. What happens when the two chemicals are mixed together and heated ?
2. Why do you have to invert the flask to collect the gas ?
3. What is the function of water sprinkled from the ink dropper ?
4. When will the water start entering the flask?
5. Why does the water enter the flask like a fountain ?

Explanation

1. When ammonium chloride and calcium carbonate are mixed together and heated, ammonia gas is formed. The following reaction takes place :
   $2NH_4Cl + CaCO_3 = 2NH_3 + CaCl_2 + H_2O$
2. Density of ammonia is less than air, so it



   will rise up in the air. Hence the flask has to be held upside down.
3. Ammonia is very soluble in water. So, when water is sprinkled inside the flask, ammonia gas gets dissolved in water and a partial vacuum is created inside the flask.
4. The water will start entering the flask after a partial vacuum is created inside the flask.
5. After the partial vacuum is created inside the flask atmospheric pressure working on the water in the beaker forces the water inside flask to gush like a fountain. The narrower the end of the tube the better will be the fountain effect.

Chemistry

Cooling by shaking

92

Materials

1. A conical flask with a rubber stopper
2. Barium hydroxide ($Ba(OH)_2$) and ammonium thiocyanide (NH_4SCN)

What to do ?

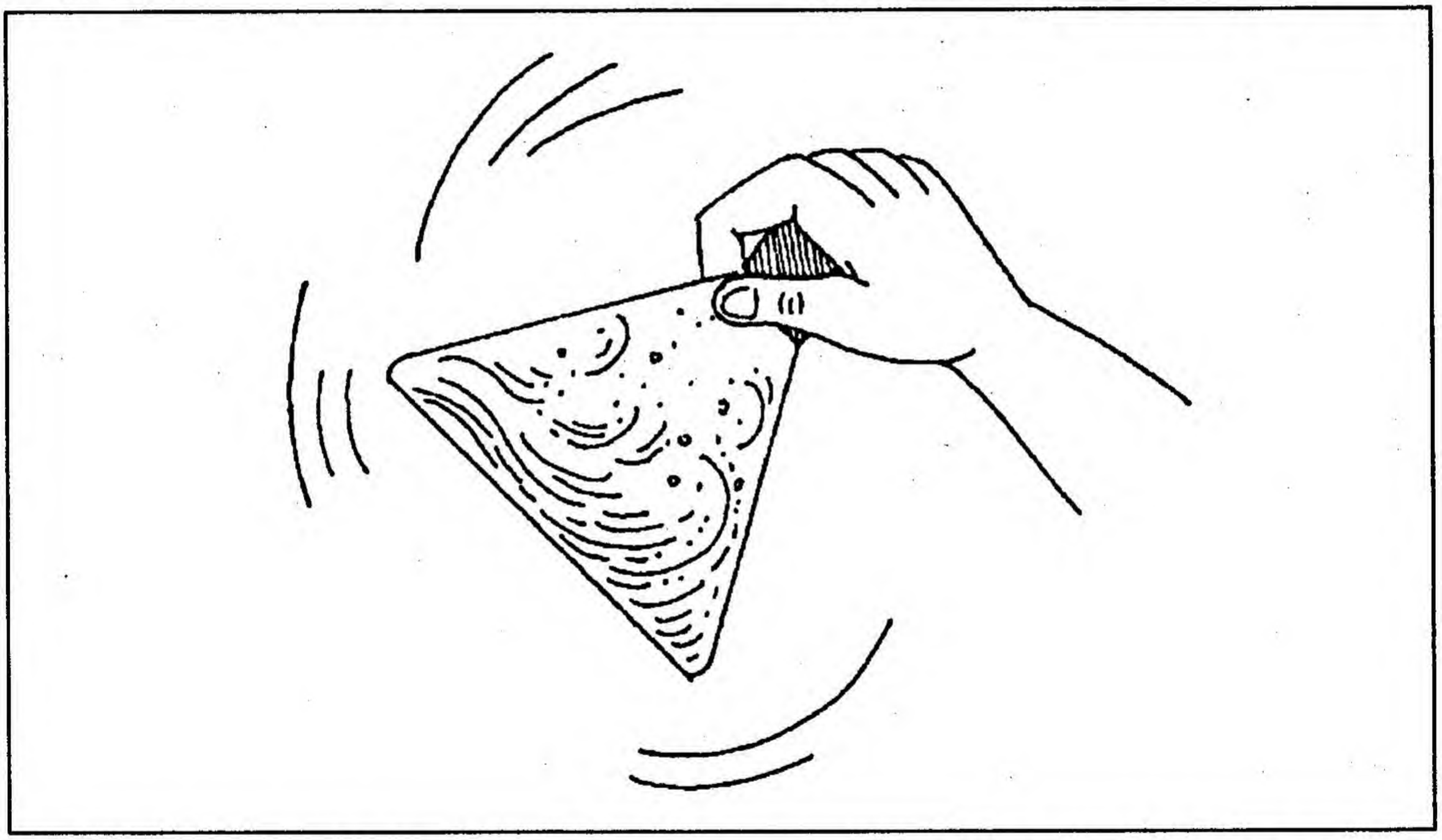
1. Take one teaspoonful of each chemical in the flask.
2. Close the mouth with the stopper and shake the flask for some time. After shaking it for some time you will observe that the flask is getting cooler.
3. If you keep the flask on a wet wooden board, it will stick to the board.

Students to enquire

1. What kind of reaction takes place between the two chemicals ?
2. Why should the wooden board be wet ?

Explanation

1. When two compounds react with each other either heat is given away or taken in. If heat is given away, it is called exothermic reaction, and if heat is taken in, it is called endothermic reaction. The above reaction is endothermic. Hence, it takes heat away from its environment i.e., from the flask. Hence the flask cools down.
2. When the flask gets cooler, it cools the water of the board to ice. Because of this, the flask gets stuck to the board.



93 Which gases are formed

Chemistry

Materials

1. Zinc granules, calcium carbonate ($CaCO_3$)
2. Potassium chlorate ($KClO_3$), dilute hydrochloric acid (HCl)
3. A spirit lamp or a heater
4. Three test tubes, a match box and a little ash.

What to do ?

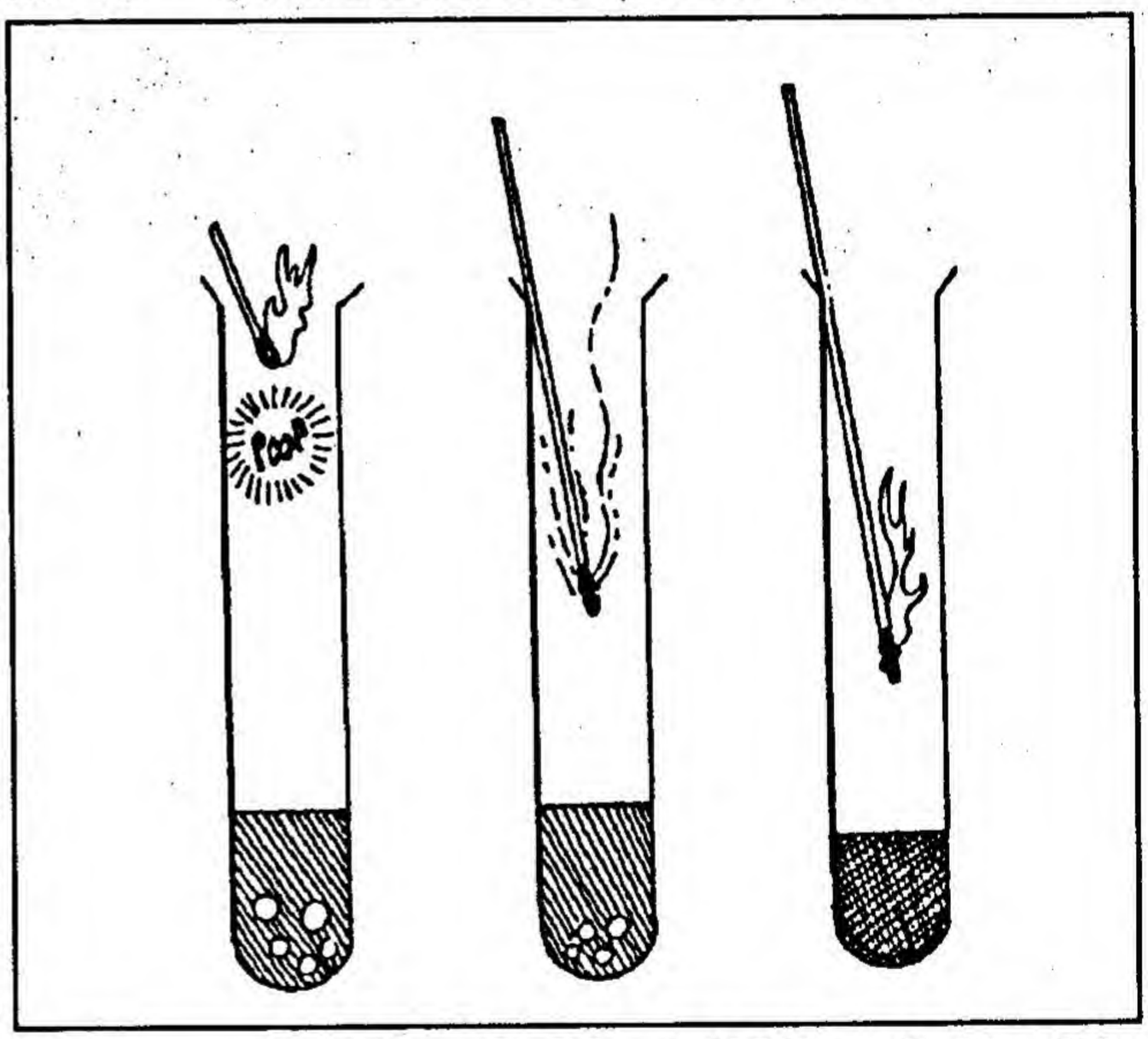
1. Take Zinc granules in the first test tube and add 3-4c.c. HCl to that. Close the mouth of the test tube with your thumb. After sometime take away your thumb and bring a lighted matchstick near the mouth of the test tube. You will observe that there will be a small explosion.
2. Take $CaCO_3$ (pieces of marble) in the second test tube and add 3-4 c.c. of HCl. Introduce a burning stick into the test tube. You will observe that the fire will extinguish.
3. Take a little $KClO_3$ mixed with ash in the third test tube. Heat the test tube. Light a wooden stick and put it off and then immediately introduce the stick into the test tube. You will observe that the stick will again light up.

Students to enquire

1. Which gas was formed in the first test tube and what is its characteristics ?
2. Which gas was formed in the second test tube and what is its characteristics ?
3. Which gas was formed in the third test tube and how is it different from the other two ?

Explanation :

1. Hydrogen was formed in the first test tube. $Zn + 2HCl = ZnCl_2 + H_2$. Hydrogen is highly inflammable. So, when the lighted matchstick is brought near it a small explosion takes place.
2. Carbon dioxide (CO_2) is formed in the second test tube. This gas does not help in combustion. It is denser than air and is colourless. $CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$.
3. Oxygen is formed in the third test tube. Oxygen helps in combustion but is not itself inflammable like hydrogen. Hence, when a lighted stick that has just been extinguished is brought in contact with oxygen the stick is ignited again. Oxygen makes up about 20% of atmospheric air.



Chemistry

Burning by ice

94

Materials

1. Sodium peroxide (Na_2O_2)
2. Lycopodium powder
3. An ice cube
4. A metal sheet

What to do ?

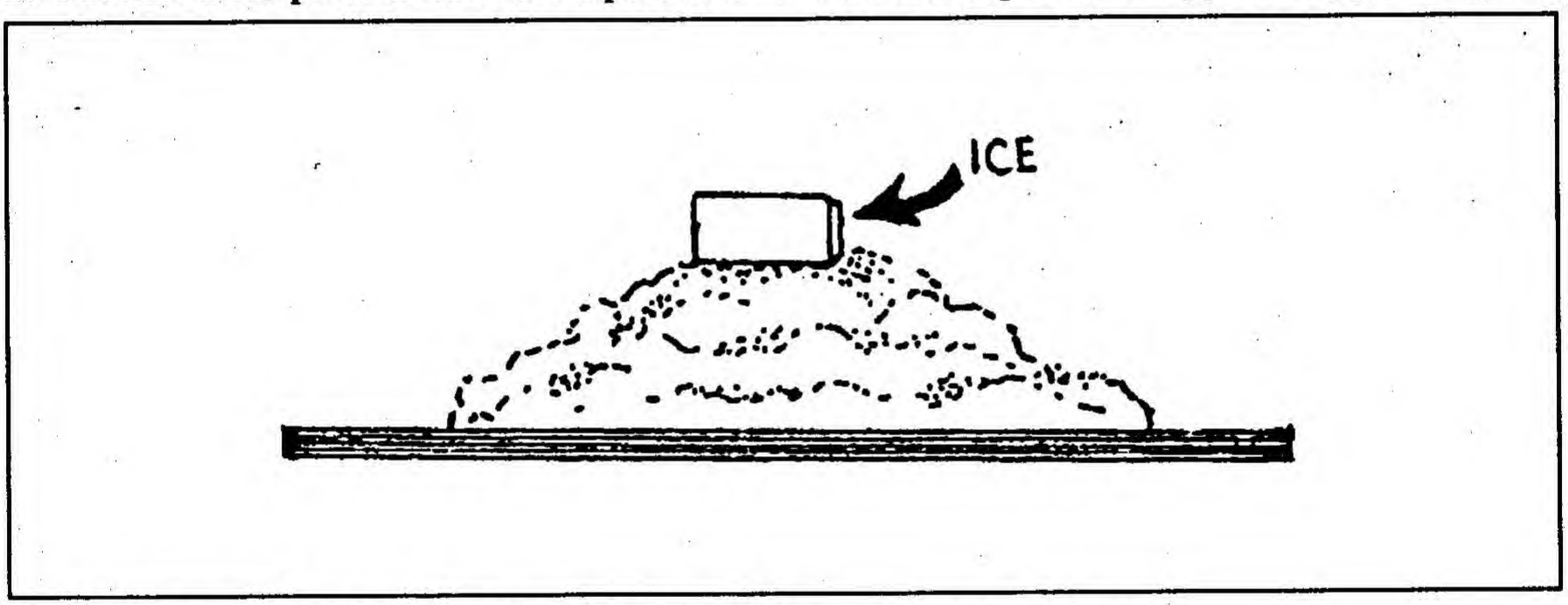
1. Take two teaspoonful of lycopodium powder in a heap on the metal plate, give the heap the shape of a cone.
2. Put half a teaspoonful of sodium peroxide on the top of the heap. Put the piece of ice on it.
3. Stand a little distance off. You will observe that the lycopodium powder will be ignited.

Students to enquire

1. What happens to the ice when it is kept at room temperature ?
2. What reaction occurs between sodium peroxide and water ?
3. What is the function of sodium peroxide ?
4. Why is the lycopodium powder ignited ?
5. Is the reaction that takes place exothermic or endothermic ?
6. What else can you use in lieu of lycopodium powder ?

Explanation

1. When ice is kept at room temperature, it will melt into water.
2. $Na_2O_2 + H_2O \rightarrow NaOH + O_n$ + energy (heat).
3. Sodium peroxide supplies oxygen for spontaneous combustion.
4. Reaction takes place between sodium peroxide and water from melted ice nascent oxygen is formed, nascent oxygen is very reactive. It oxidizes the carbon in the lycopodium powder and spontaneous combustion starts. This sets the lycopodium powder into flame.
5. The reaction is exothermic.
6. You can use tissue paper, fine saw dust, or starch instead of lycopodium powder.



95 Disappearing precipitate

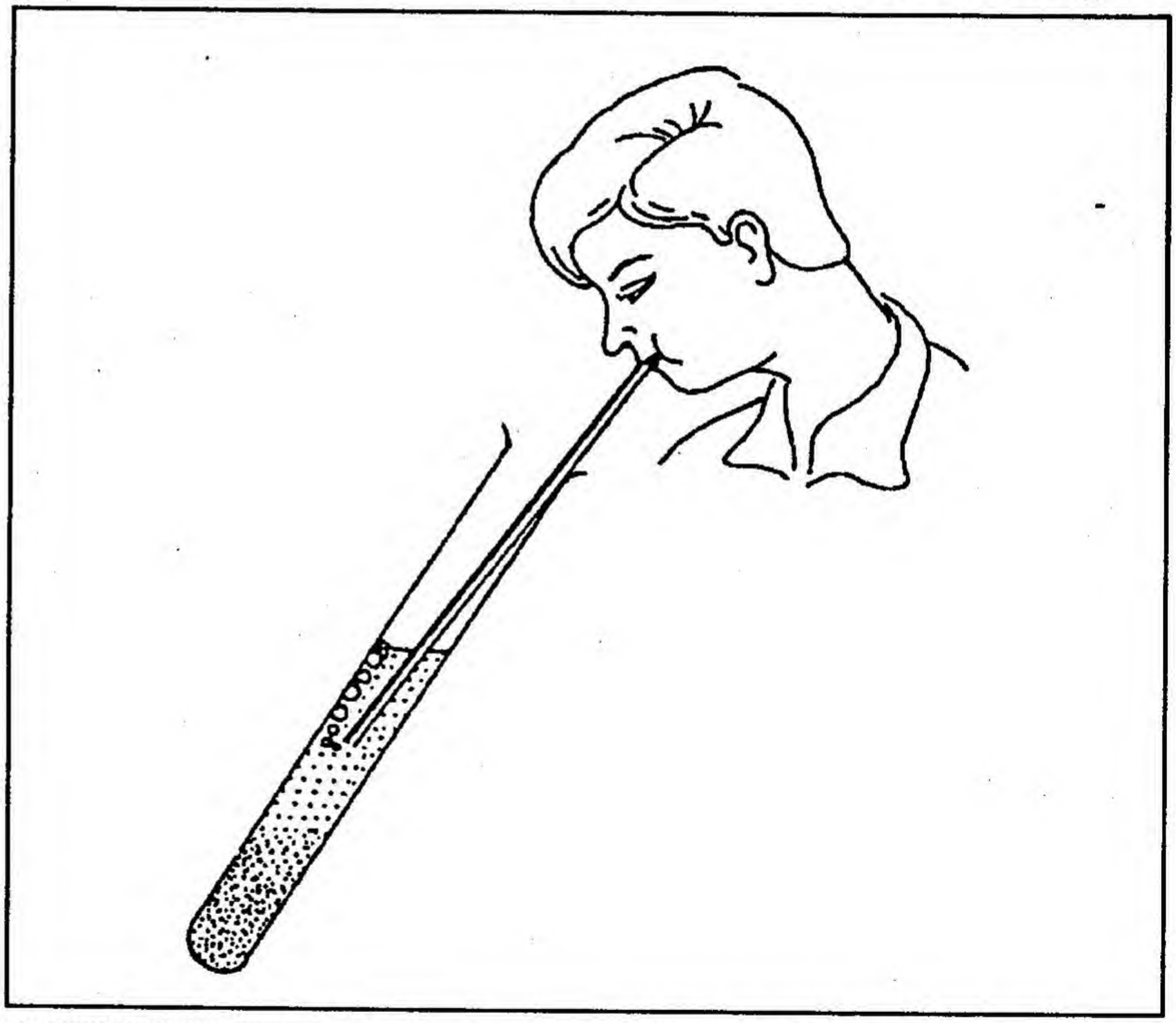
Chemistry

Materials

1. Calcium hydroxide ($Ca(OH)_2$)
2. A test tube
3. A drinking straw
4. Filter paper

What to do ?

1. Fill half the test tube with calcium hydroxide solution. If $Ca(OH)_2$ is available in powder form, then prepare a saturated solution of $Ca(OH)_2$ in warm water, keep the solution for some time and then filter out the clear water from the top.
2. Blow air into the solution through the straw. You will observe that the solution starts becoming cloudy due to the formation of a white precipitate.
3. If you continue blowing air into the cloudy liquid, it will gradually clear up.



Students to enquire

1. Why does the precipitation take place ?
2. Normally, when does precipitation occur ?
3. Why does the precipitate disappear ?

Explanation

1. When you blow into the solution carbon dioxide (CO_2) is added to the solution. CO_2 reacts with calcium hydroxide ($Ca(OH)_2$) and calcium carbonate is formed which is insoluble in water. Hence a precipitate is formed. $CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$.
2. When the solubility of a substance in a liquid is less, precipitation takes place.
3. When you continue blowing more CO_2 into the precipitate calcium bicarbonate ($Ca(HCO_3)_2$) is formed. $CaCO_3 + H_2O + CO_2 = Ca(HCO_3)_2$, Calcium bicarbonate is soluble in water. Hence the precipitate disappears.

Chemistry

Colour magic - 1

96

Materials

1. A 250 c.c. conical flask with rubber stopper
2. 5 gms. potassium or sodium hydroxide
3. 3 gm. glucose or dextrose
4. Methylene blue

What to do ?

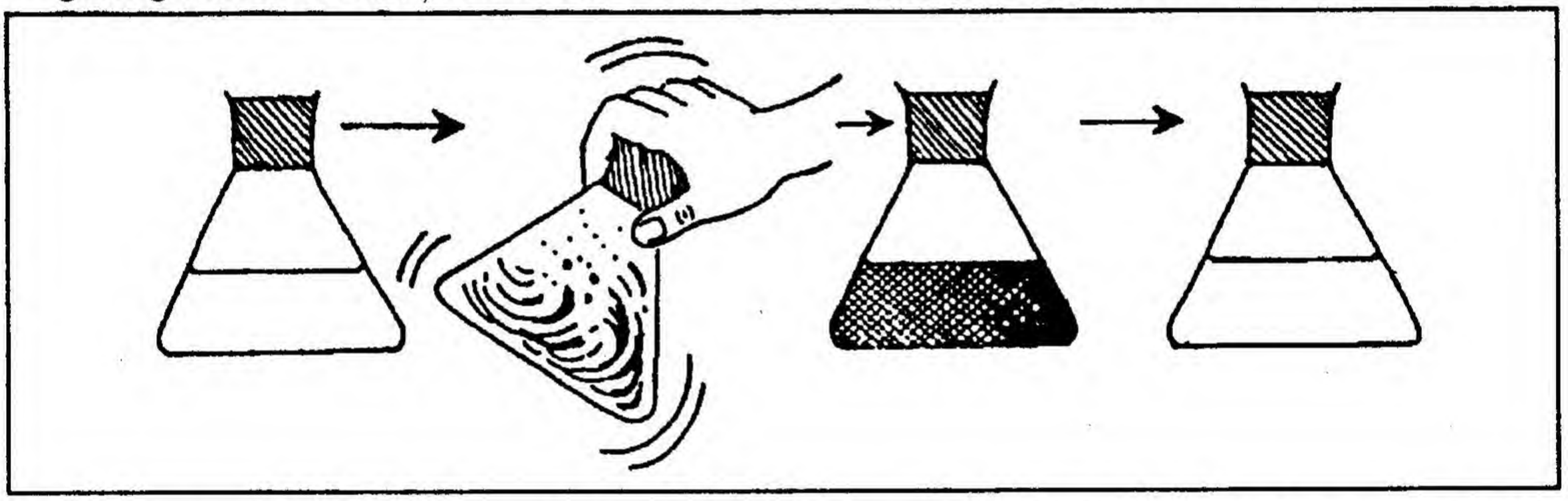
1. Dissolve 5 gms. potassium hydroxide and 3 gms. glucose in water in the flask. Add a few drops of methylene blue in the liquid. A colourless liquid will be formed.
2. Close the mouth of the the flask by the stopper and shake the flask. You will observe that the colourless liquid be changed to a deep blue colour.
3. Keep the flask on the table for some time. The liquid will again become colourless.
4. Shake the flask and the deep blue colour will appear again. Keep the flask still for some time and the colour will disappear.

Students to enquire

1. Why does the deep blue colour appear on shaking ?
2. Why does the colour disappear on keeping still ?
3. Can the experiment be conducted repeatedly ?
4. What is the nature of the chemical reaction which is taking place ?

Explanation

1. In an alkaline solution of a reducing sugar, methylene blue is reduced to a colourless compound. On shaking, the oxygen in the air inside the flask dissolves in the liquid and the colourless solution is reoxidized into the blue dye. The solution turns deep blue.
2. When the flask is left still for some time, the oxygen goes out of the solution. The solution is reduced again and its colour gradually fades away.
3. The experiment can be repeated several times but after a few days the solution will turn yellow and then brown.
4. It is a reversible oxidation-reduction reaction.



97 Colour magic - 2

Chemistry

Materials

1. Six test tubes on a stand
2. Dilute hydrochloric acid
3. Liquid sodium hydroxide
4. Phenolphthalein
5. A drinking straw
6. A glass and an ink dropper

What to do ?

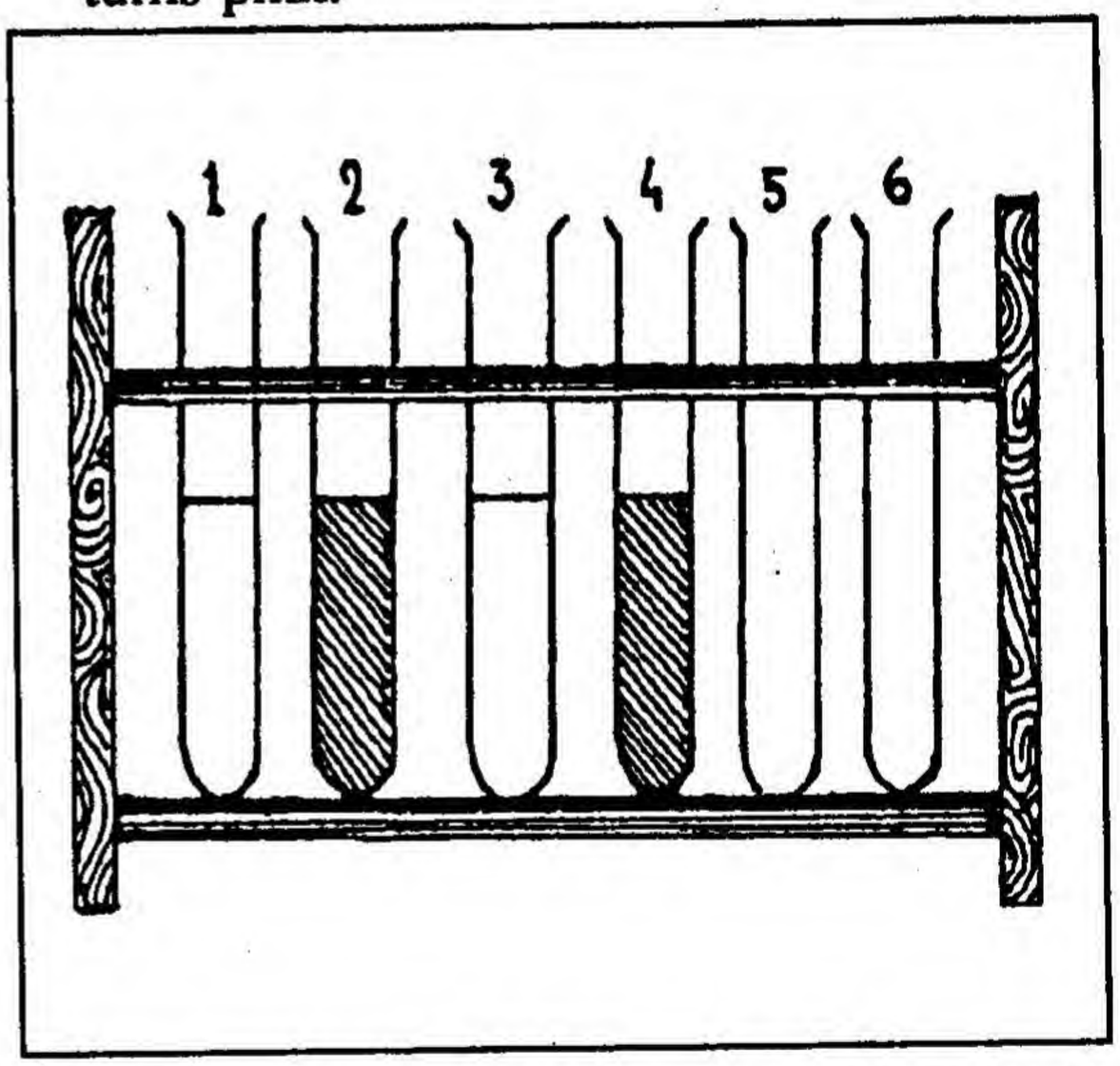
1. Number the test tube 1 to 6 from the left.
2. Place three drops of phenolphthalein indicator in the test tubes 2 and 4. Take one drop of sodium hydroxide in the test tube 6 and in the glass. Take three drops of hydrochloric acid in the test tube 5.
3. Fill the glass three-fourths full with water. Now fill the test tubes 1, 2, 3 and 4 half full with water from the glass. You will observe that the liquids in the test tubes 2 and 4 turn pink.
4. Now, pour the liquids from the four test tubes into the glass.
5. Now fill the test tubes from 1-5 with the liquid from the glass. Except in the test-tube 5, liquids in all other test tubes will show pink colour.
6. Now pour the liquids from all the test tubes into the glass and fill up again all the six test tubes. You will observe that only the test tube 6 will show pinkish colour.

Students to enquire

1. Why do the liquids in the test tubes 2 and 4 turn pink ?
2. Why does the liquid in the test tube 5 turn colourless ?
3. Why does the liquid in the test tube 6 show pink colour ?

Explanation

1. Phenolphthalein is an indicator for alkaline solution. It turns pink in a dilute solution of sodium hydroxide. There was phenolphthalein in test tubes 2 and 4 and sodium hydroxide in the glass. When water is added in the glass an alkaline solution is created. So, when the alkaline solution is added to the test tubes 2 and 4 the phenolphthalein turns pink.



2. There is hydrochloric acid in test tube 5. When the pink alkaline solution is poured into the test tubes 1 to 5, the alkaline solution is neutralised by the hydrochloric acid in the test tube 5. Hence the liquid in the test tube 5 becomes colourless. Phenolphthalein is colourless in neutral solution.
3. As the test tube 6 contains sodium hydroxide, the solution becomes alkaline again and phenolphthalein in alkaline solution turns pink in colour.

Chemistry

Making a cracker

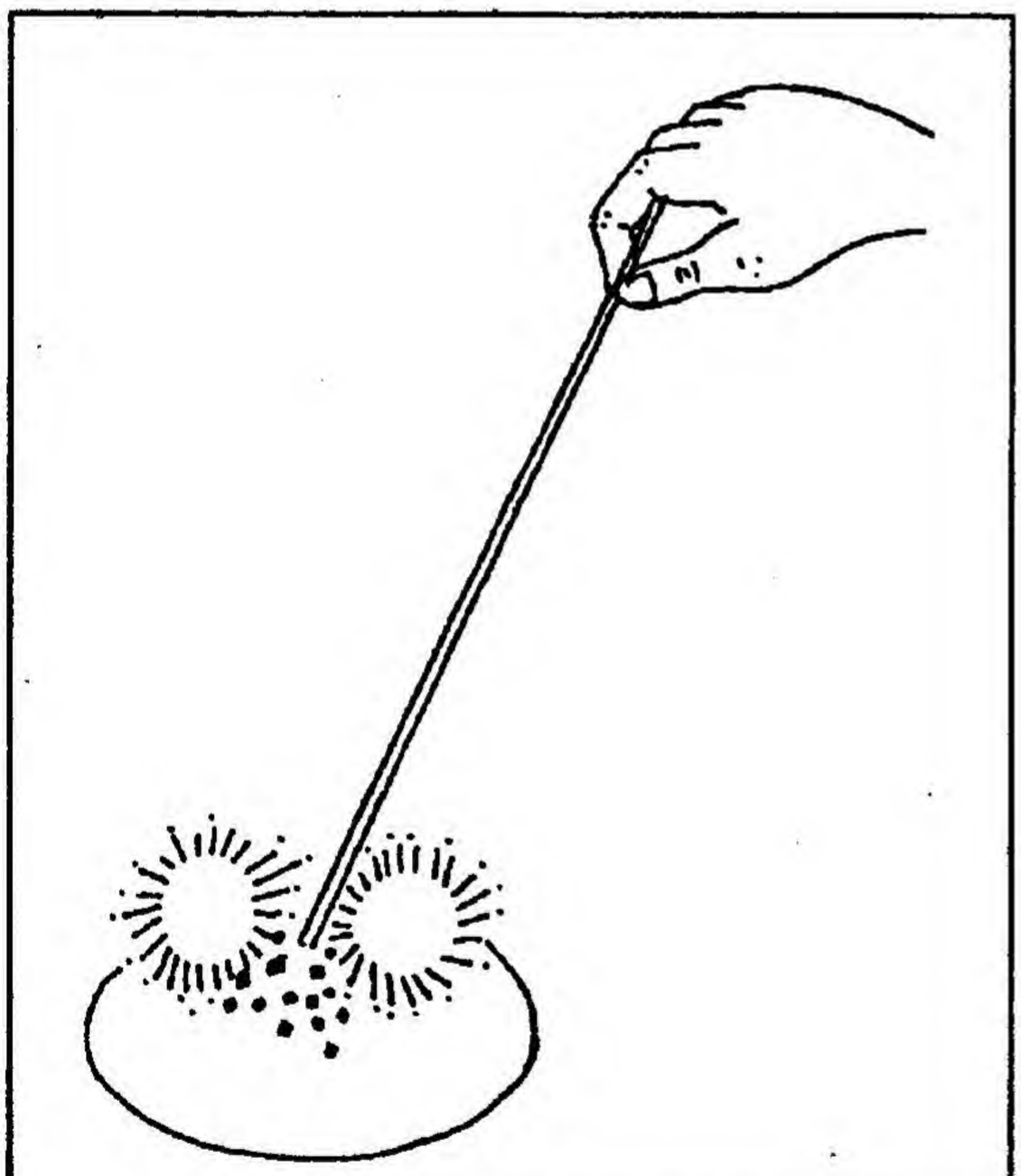
98

Materials

1. A stick one metre long.
2. Filter paper
3. Iodine crystals
4. Concentrated ammonia
5. A 100 c.c. beaker

What to do ?

1. Dissolve iodine crystals in concentrated ammonia in the beaker. Be sure that all the crystals are dissolved. Stir the liquid with a glass rod.



2. Let the beaker stand in the air till a brown residue is left in the beaker.
3. When the residue is still wet, scratch out the residue with the help of the stirrer on the filter paper. Allow it to dry. It will take about an hour to dry. The more dry the residue the better the experiment.
4. Stand about a metre apart from the filter paper and then tap the dried up crystals with the help of the long stick. Tap only a few crystals at a time because the crystals are highly explosive.

Students to enquire

1. Which compound is formed when iodine crystals are dissolved in concentrated ammonia ?
2. Why is the compound so explosive ?
3. Why do we hear a loud report when there is an explosion ?
4. Is oxygen always needed whenever there is an explosion ?

Explanation

1. When iodine crystals are dissolved in concentrated ammonia, nitrogen tri-iodide is formed.
2. Wet nitrogen tri-iodide is not that dangerous. But when much of ammonia gets evaporated, dry nitrogen tri-iodide becomes unstable. When it is tapped by the stick, it explodes. If the amount of nitrogen tri-iodide is less, then there is less danger of a big explosion.
3. As a large amount of gas is produced during an explosion, there is a loud sound.
4. When there is a sudden release of a large volume of gas, there is a loud sound. As for example, when a balloon is pricked the air under pressure is suddenly released. Hence, there is a loud sound. Oxygen is not indispensible for an explosion to occur.

99

Acid heats up

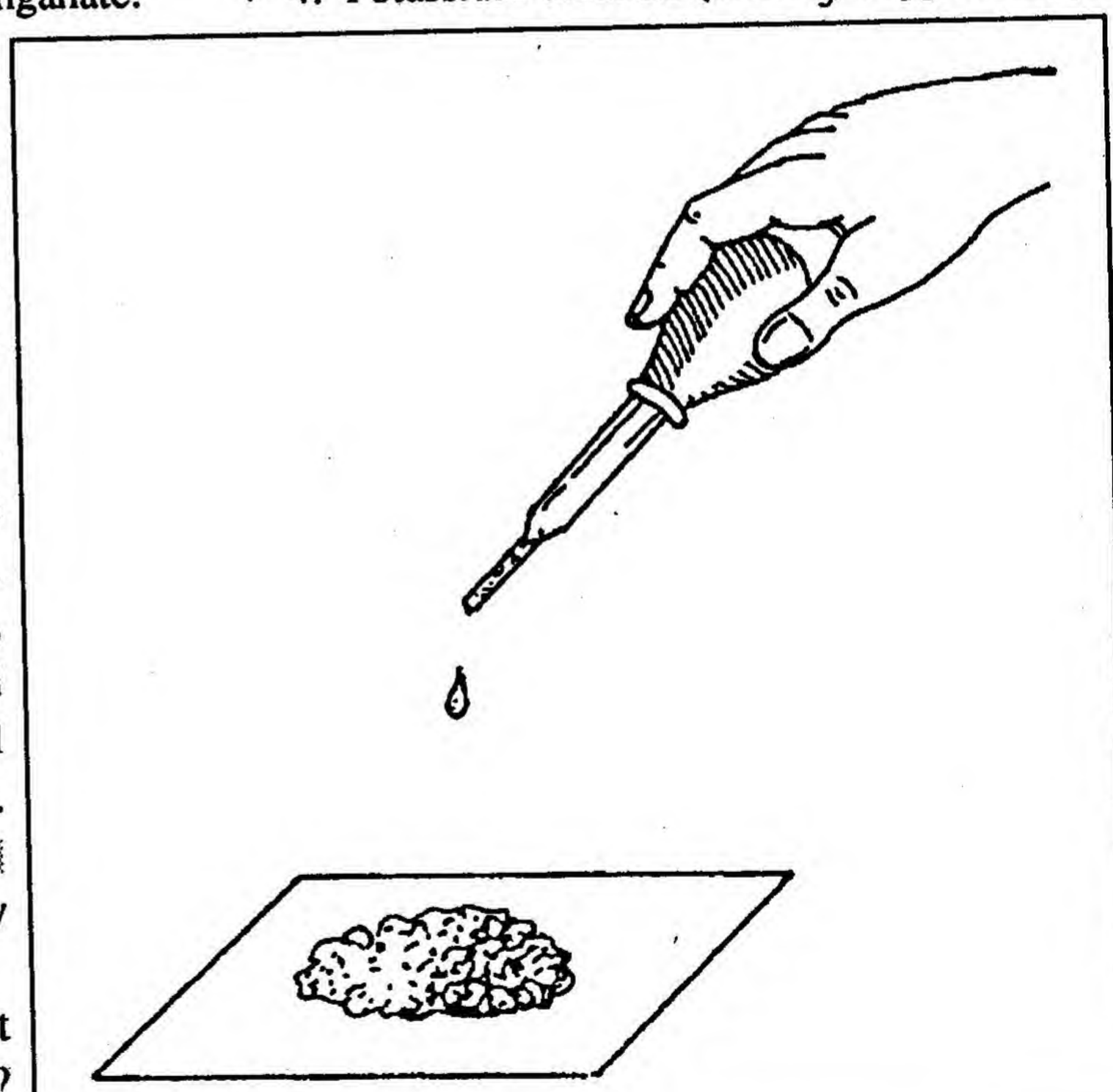
Chemistry

Materials

1. Potassium chlorate ($KClO_3$)
2. Potassium permanganate ($KMnO_4$)
3. Ground sugar
4. Concentrated sulphuric acid (H_2SO_4)
5. An ink dropper, a watch glass

What to do ?

1. Mix on the watch glass sugar, potassium chlorate and potassium permanganate.
2. Pour a drop of sulphuric acid on the heap of the mixture with the help of the dropper. Drop the acid from a distance. It is advisable to conduct the experiment in the open. Take great care while handling the acid.
3. You will observe that the mixture will catch fire and a large volume of gas will be produced.
4. If a little barium, strontium, copper or sodium salt is added to the mixture, then you will observe the magic of colours.



Students to enquire

1. What is the source of energy for the generation of heat ?
2. Which one among the different kinds of powder was burning ?
3. Where did the heat come from for the spontaneous combustion ?
4. Which gases are formed in the reaction ?

Explanation

1. The chemical energy stored in the chemical compound is converted into heat energy.
2. It was the sugar powder that was burning.
3. Sulphuric acid supplied the first heat to generate oxygen from potassium chlorate. The heat helped in the generation of nascent oxygen from potassium chlorate. This oxygen oxidized the sugar and so much heat was liberated that the sugar caught fire.
4. Potassium chlorate ($KClO_3$) supplied oxygen for combustion.
5. Carbon dioxide and water vapour are formed by combustion.

Chemistry

Invisible writing

100

Materials

1. Cobalt chloride crystals
2. Ammonium chloride
3. Distilled water
4. A little cotton
5. A piece of pink paper
6. A candle, a match box and a wooden stick

What to do ?

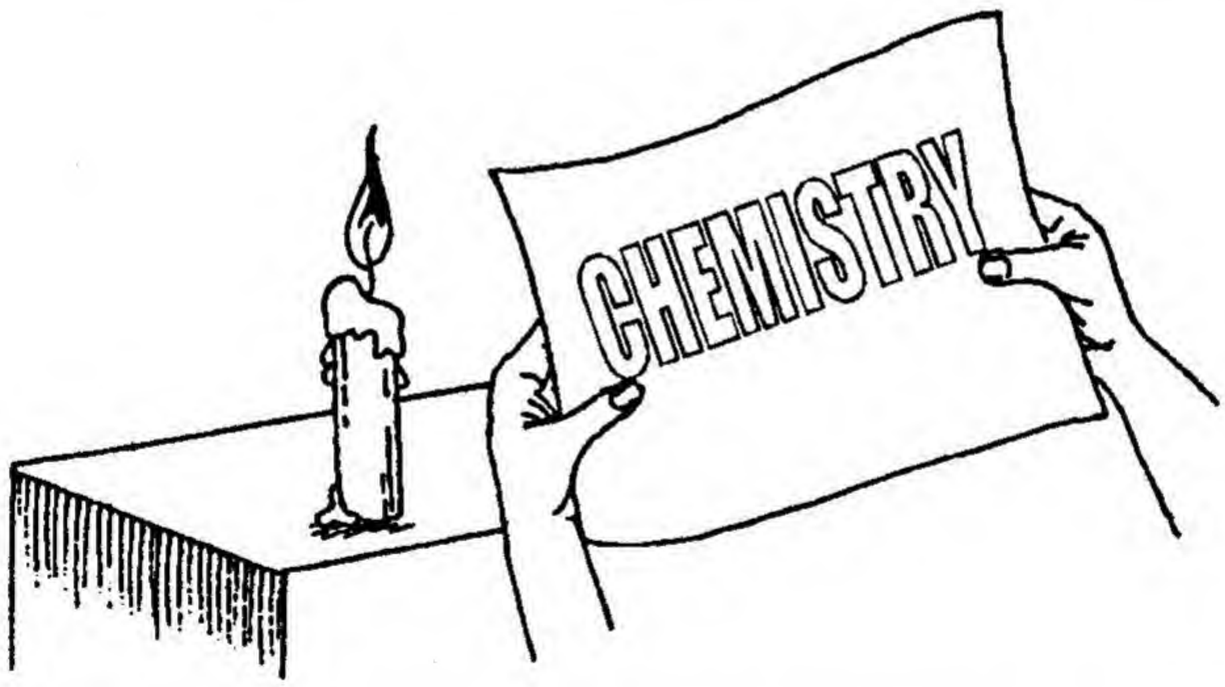
1. Mix $1^1/_2$ gms. ammonium chloride with $2^1/_2$ gms. of cobalt chloride. Add 50 c.c. of distilled water and make a solution. You will observe that the colour of the solution will be deep pink.
2. Wrap a little cotton at one end of the stick. Dip the cotton in the solution and write the word "chemistry" on the pink paper.
3. Allow the paper to dry, you will observe that the inscription will gradually disappear.
4. Now, light the candle and bring it near the paper so that the written word may get the heat from the flame of the candle.
5. You will observe that the word "chemistry" will reappear in bright blue colour. When the paper cools down the inscription disappears again.

Students to enquire

1. When you write on the pink paper, why does it disappear when the paper dries up ?
2. Why does the inscription reappear on heating ?
3. Why does the inscription disappear again on cooling ?

Explanation

1. As the colour of both the paper and the solution is pink, inscription disappears.
2. When cobalt chloride goes into solution, a complex compound is formed which releases water on heating. In this condition the colour of the compound is blue.
3. When the paper cools, it absorbs moisture from the atmosphere and the pink colour of the solution reappears. Hence inscription disappears again.



101 Chemical ice-cream

Chemistry

Materials

1. 100 grams sugar
2. A tall jar
3. A small glass tumbler
4. Concentrated sulphuric acid

What to do ?

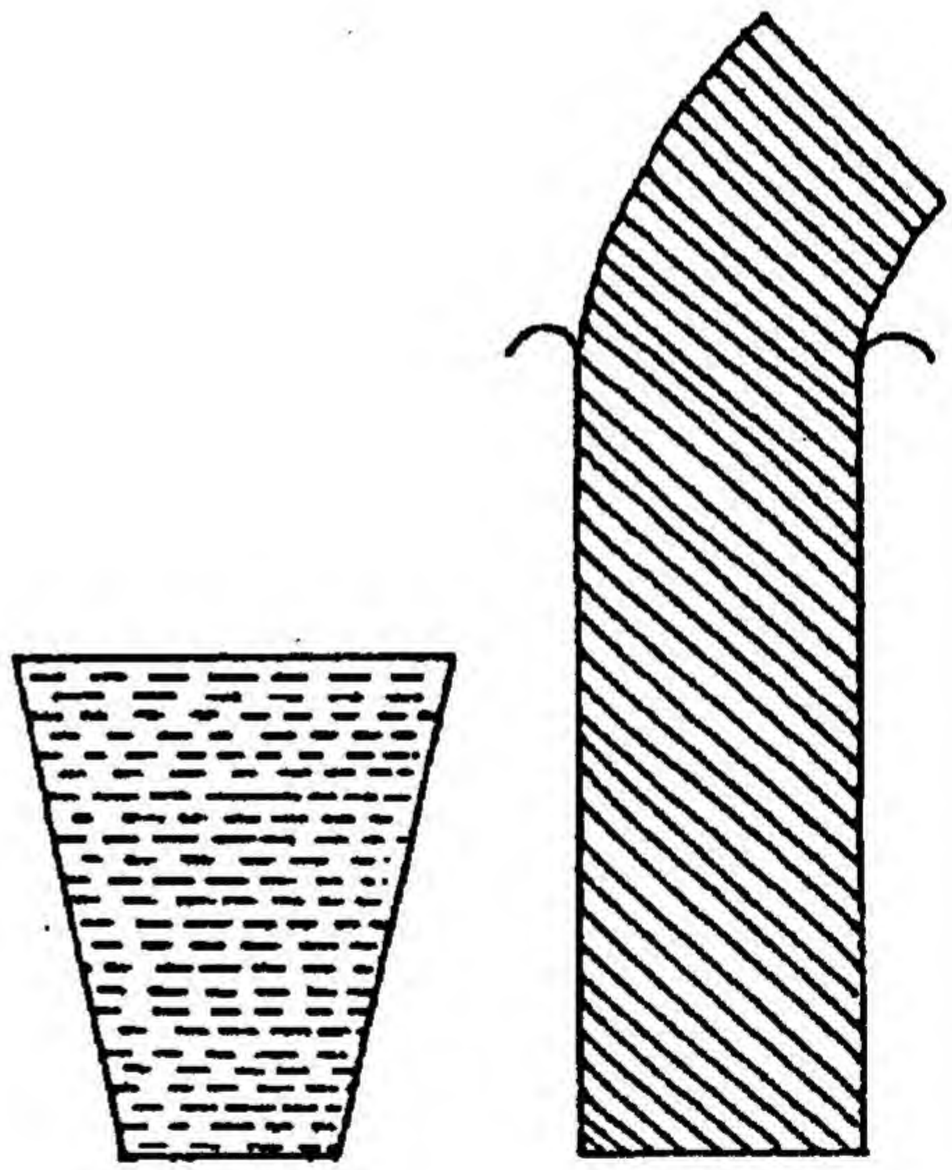
1. Fill half the glass and the jar with sugar.
2. Pour some water in the glass and about 40 c.c. of concentrated sulphuric acid in the jar.
3. Wait for some time. You will observe that in the glass the sugar will dissolve in water. But in the jar a blank voluminous substance will be produced which will gradually rise up in the jar and come out of it.

Students to enquire

1. What is the black substance in the jar ?
2. What is the difference bctween the processes that take place in the glass and in the jar ?
3. What difference did you observe in the experiment between the physical and chemical processes ?
4. From which container can you separate the sugar and how ?
5. What happens in the jar ?

Explanation

1. The black substance in the jar is charcoal.
2. The process that takes place in the glass is a physical change. But a chemical change takes place in the jar.
3. In a physical change you can bring back the original substances. But in a chemical change original substances cannot be brought back easily.
4. You can separate the sugar from the sugar solution in the glass by the evaporation of water by heating.



5. The sulphuric acid reacts with sugar chemically. As a result, charcoal, sulphur dioxide gas and water vapour are formed. These gases cause the expansion of charcoal into a voluminous mass.